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User's Guide to the Parallel Processing Extension of the Prognosis Model

**Nicholas L. Crookston
Albert R. Stage**

$CE = C_i (CCF -)$
$B = \frac{\pi}{360} \int_0^\infty x e^{-x} X dx$
$\ln [\Delta H] = f_H [\Delta D, H, D]$
$MORT = \frac{1}{1 + \exp [-B_i x_i]}$
$\ln [BAI] = f_B [D.b.h., Habitat, Crown]$

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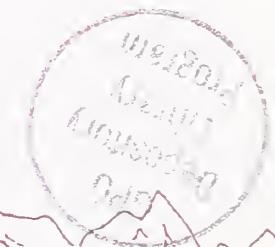$Height = \exp(B_i x_i)$
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If
Riparian EQ
YES and BTPA LT 150
and BADBH GT 12 Then
Perform one-entry shelterwood

THE AUTHORS

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RESEARCH SUMMARY

The Parallel Processing Extension (PPE) of the Prognosis Model was designed to analyze responses of numerous stands to coordinated management and pest impacts. Vegetation-related resource supply analysis can be readily performed for a thousand or more sample stands for projections 400 years into the future.

The PPE is a multistand simulation model that combines an individual-tree distance-independent stand model, a method for specifying management policies using rules in addition to predetermined activity schedules, capability for representing spatially-dependent interactions between stands, capability to represent contagious agents that influence forest dynamics, the ability to simulate and display management alternatives using decision trees, and the ability to simulate multistand treatment scheduling. Nontimber resources are explicitly represented by system components and through links with other models.

This user's guide describes what the PPE does, how it works, and how to use it.

ACKNOWLEDGMENTS

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INTRODUCTION

The Parallel Processing Extension (PPE) to the Prognosis Model (Stage 1973; Wykoff 1986; Wykoff and others 1982) is a multistand simulation model that provides the following capabilities:

- Simulation of the simultaneous development of a thousand or more forest stands for up to 400 years into the future, including dynamic inter-actions between stands. With this capability, the system can simulate effects of contagious pests and management prescriptions that depend on conditions in surrounding stands and at the landscape level.

- Comparison of effects of applying alternative management policies to a collection of stands. Alternatives may differ in the conditions under which specific treatments will be applied, in the way stands are classified for prescription, and in the timing of application. Numerous policies may be evaluated in the same simulation.

- Processing and displaying alternatives using decision trees. If some of the alternatives represent outcomes of uncertain events, then expected values can be calculated using the probabilities associated with the uncertainty as weights in the expectation.

This user's guide is divided into three sections and appendices. Not all readers need to read all of the guide. However, in writing the guide, we have assumed that you have a general knowledge of the Prognosis Model. Read Wykoff and others (1982), Wykoff (1986), Crookston (1990), and Ferguson and Crookston (1991) to gain the required background.

The first part of the guide, "What the PPE Does," explains the model's capabilities. The goal is to provide you with the information you need while deciding if the PPE would be useful to you. We describe some solutions to problems forest managers, pest managers, planners, and research scientists have encountered that can be solved using the PPE. We have included some simple examples to illustrate the problem-solving approaches offered by the PPE. Solving some of these problems can consume significant computing resources; approaches to managing computing tasks are described.

The second section is "How the PPE Works." We provide a narrative description of what goes on inside the program and describe the program output. Note that an in-depth understanding of the Prognosis Model is needed to understand this section. The PPE may be used to solve other problems besides those described under "What the PPE Does." An additional goal of the second section is to provide relevant information to people who are considering adapting the PPE to meet new needs.

The third section, "Using the PPE," explains what you must do to make the PPE accomplish the task you have in front of you. Here, the keyword commands used by the model are presented in detail. Once you start using the PPE, this section will become a reference guide.

Five appendices are included. Appendix A lists some of the output produced when running the examples.

Appendix B contains the formats of machine-readable files output by the system and some other information relevant for programmers and analysts.

Appendix C presents a detailed description of how policy labels are manipulated by the PPE. It is presented to further clarify the basic principals described in the text.

Appendix D is a listing of the keyword file used in example 4.

Appendix E lists the PPE keywords in alphabetical order. This appendix is useful if you already know the PPE's vocabulary and only need to refresh your memory as to the command format and arguments.

The use of the words "parallel processing" in the name of this Prognosis Model extension needs an explanation. First, parallel processing computers are not required to use the PPE. The "parallel processing" done by the PPE uses traditional computers that operate in serial mode. However, the name is appropriate to the task of representing several stands in parallel. It is distinctly different from running several stands one after another, independently, and serially. Hence, we have chosen to use the name PPE.

The Prognosis Model has been calibrated for several regions of Western North America. Each region is covered by a separately calibrated variant. This version of the PPE can be linked to any variant based on version 6.1 of the Prognosis Model. Therefore, the PPE is applicable to most of the forested land in the Western United States and parts of British Columbia.

The program is available in source code form, it is written in FORTRAN 77, and it requires an operating system that allows a single program to use about 2 million bytes of memory. The program has been tested on IBM mainframe computers under CMS and MVS, Data General MV computers under AOS/VS, and an Intel 486-based machine running UNIX. Disk space and computer time resources used by the program depend on the size of the problem being solved. Contact the authors for program availability.

WHAT THE PPE DOES

The PPE can simulate multistand treatment scheduling at the landscape level, accomplish resource supply analysis, simulate contagion in pest-dynamic models, and create and analyze decision trees. The PPE was designed to evaluate management policies. A stand management policy is defined as a set of rules for stand management. A multistand treatment policy is a rule that applies to groups of stands.

This section describes the capabilities of the PPE. An introduction to policy evaluation is included that defines terms and demonstrates the approach used. The section ends with a description of composite yield table generation and guidelines on controlling simulation costs.

Multistand Treatment Scheduling

The multistand treatment scheduling component of the PPE allows you to specify treatment policies made of these elements:

- The name or label for the policy.
- The target, expressed as a function of multistand-level state variables.
- The contribution of each stand toward meeting the target, expressed as a function of stand-level variables.
- The relative priorities for treating individual stands, expressed as a function of stand-level variables.

More than one multistand treatment policy can be specified. A solution for each policy is computed, or two hierarchical policies may be considered. When a hierarchy is computed, stands are first selected to meet the first target, then the model selects stands for treatments designed to reach the second target from those that were not selected to reach the first.

You specify the treatment prescription for each stand predicated on it being selected for treatment under the multistand treatment policies. Treatments predicated on the stand not being selected may also be specified. These prescriptions form the stand management policy for each stand. The PPE and Prognosis Model use a policy labeling scheme to associate stand management policies with the multistand treatment policies. Details of how this scheme works are described in the following pages.

Example—To illustrate multistand treatment scheduling the following scenario is presented. The goal for the management of a contiguous area is to maintain significant acres of cover (suitable for wildlife hiding cover), produce a biologically diverse environment, and produce timber. This example uses a contiguous collection of 119 stands totaling 3,266 acres from the Nez Perce National Forest, ID.

The approach is to use the policy hierarchy facility of the PPE. The target for the first policy is expressed as a number of acres that meet a specific definition of cover. Harvesting for timber production is done on acres that are not "set aside" for cover. An assumption is made that holding some stands for cover while harvesting other stands will produce a biologically diverse environment. While the amount of diversity is not explicitly targeted nor computed by the PPE, it can be computed by processing the PPE output files. Many metrics of environmental status are possible besides those directly produced by the model.

A stand is said to provide cover if the canopy closure is greater than 70 percent and the top height is greater than 40 feet. The priority scheme for choosing stands to provide cover assumes that the greater the closure, the better the cover. However, if two stands have the same closure, and one has less timber volume, the stand with the lower volume (presumably this is also the younger of the two stands) is given a higher priority for selection as cover. During the time a stand is retained for cover, harvesting and thinning are not permitted.

Stands not needed for cover are placed in a group that can be harvested or otherwise treated according to appropriate silvicultural prescriptions. The harvest target is based on the Austrian formula for determining a regulated annual cut (Davis 1966, p. 135):

Annual cut = annual increment + ((present growing stock − desired growing stock)/an adjustment period)

The annual increment is computed by subtracting the average mortality over all of the stands in the analysis from the average accretion. The present growing stock is the average volume over all stands. For this example, the desired average growing stock is assumed to be 5,000 ft³/acre and the adjustment period is to be 50 years. We desire a periodic total cut rather than an annual cut per acre, so the formula is scaled by the period length and the total acres. The periodic harvest targets are based on alternately harvesting twice the regulated annual cut for two decades, followed by no harvest for two decades, then repeating this pattern to the end of the simulation.

The stand-level policies define the silviculture that is to be applied to each stand. The activities to be simulated when the stands are "selected" for harvest depend on the aspect and habitat type of the stand. The stands were classified into three groups; a different prescription is applied to each group. The first prescription is shelterwood-cut, pile and burn; the second is clearcut and broadcast burn; and the third is seedtree cut and broadcast burn. A part of each prescription is to plant if natural regeneration does not provide adequate stocking. After the stands have been harvested once, stocking control is invoked as needed in stands that are not designated cover.

Two projections, each for 250 years, were made. The first was made using the conditions described above and the second was made with no cover target specified. Figure 1a displays the percentage of area that meets the definition of adequate cover for the *cover* and *no required cover* alternatives. The requirement for cover is nearly met by the model for both alternatives for the first 80 years, then the alternative that lacks a requirement for cover fails to produce required cover whereas the alternative that contains a cover requirement generally meets or exceeds the cover objective. Figure 1b demonstrates that the harvest targets for both alternatives are almost equal for both alternatives for the first 80 years, then the alternative that contains a required cover objective produces more timber than the alternative that does not contain a cover requirement. This result is further demonstrated in figure 1c. The total production (standing volume plus cumulative harvests) is greater for the *cover* alternative than for the *no required cover* alternative.

An explanation of these results is in order. The cover alternative contains a policy rule that prohibits *any* entries in stands that are serving as cover. There are also rules that call for intermediate harvesting in stands that are stocked above some specified stocking guidelines. In the cover alternative, these intermediate entries were blocked by the policy that prohibits entries in cover-producing stands. When the *no required cover* alternative was simulated, the prohibition did not exist, resulting in the intermediate harvests being carried out in all stands. However, these intermediate harvests were apparently too severe because they reduced the timber production.

Figure 1d illustrates a measure of biological diversity that is derived from PPE output and spatial information. This measure is the percentage of the total stand boundary lines where the top height between adjacent stands is greater than 60 vertical feet. Edge habitat is considered an important commodity for big game when it is coupled with feeding sites and nearby hiding cover. If the vertical distance between top heights of neighboring stands is greater than 60 feet, a distinct edge is formed. For this
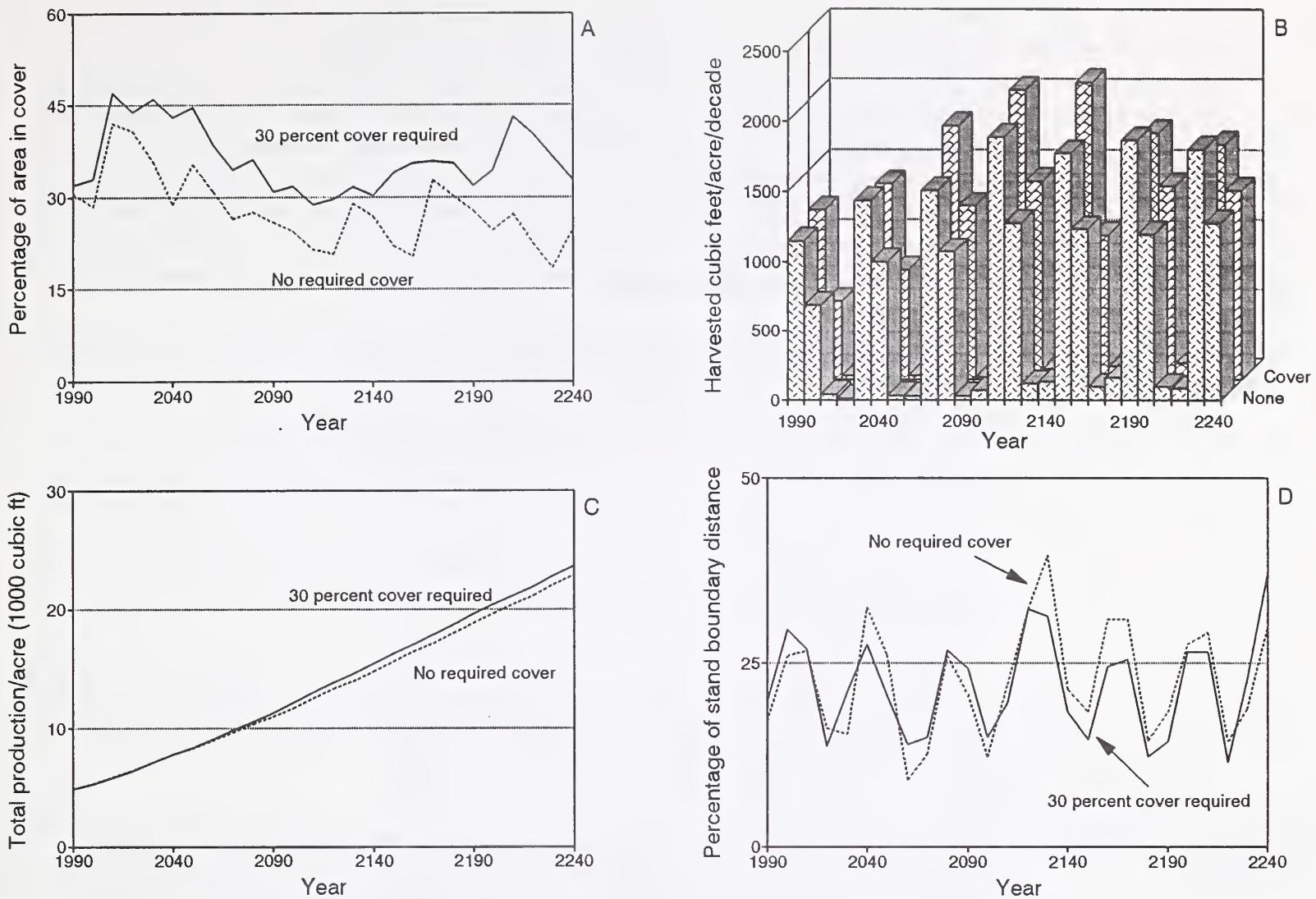
Figure 1—Long-term projection of 119 stands representing 3,266 acres, Nez Perce National Forest, ID. (A) Percentage of area that has a canopy closure over 70 percent and a top height greater than 40 feet. Two lines display the results for the *30 percent cover required* and *no required cover* alternatives. (B) Harvested ft³/acre/decade for *30 percent cover required*, labeled "Cover," and *no required cover*, labeled "None," alternatives. The alternating tall bars result from alternatively targeting twice and regulated cut for two decades, followed by no harvest for two decades, then repeating this pattern to the end of the simulation. (C) Average total production (1,000 ft³/acre) for both alternatives. The *30 percent cover required* alternative yielded slightly higher total production then the *no required cover* alternative. (D) Percentage of stand boundary distance where the difference in neighboring stands top height is greater than 60 feet.

example, there is generally more edge habitat produced for the no cover required alternative as compared to the cover alternative.

Discussion—This example illustrates that multistand treatment scheduling can target nontimber attributes such as cover. Emphasis can be given to what is left in a forest when what is left is more important than what is removed. The example also illustrates that unique silvicultural prescriptions can be used in each stand for each policy alternative and that a single multistand treatment policy may be specified as a hierarchy of two policies. The example does not illustrate some other important capabilities of this system, notably that several treatment alternatives can be specified

and concurrently run and that a single multistand treatment schedule can be sensitive to constraints on maximum clearcut size.

Stands are good inventory units, but they are almost never managed as units. Foresters create management units (often these are harvest units) by combining parts of stands into a land area that is treated in a coordinated way. The silvicultural prescriptions may vary in different parts of the management unit. Simulating this approach to management with the original Prognosis Model is complicated by the fact that this model—as with most forest growth models—simulates the growth and development of stands.

The PPE recognizes management units as groups of stands whereby all are "selected" or "not selected" at the same time. The priority for selecting a management unit is the highest priority given to any stand in the unit. The contribution toward meeting the target derived from the unit is the sum of the contributions from individual stands. The silviculture for each stand in a management unit can be unique. In the PPE, management units are groups of entire stands. The job of overlaying management unit boundaries with stand boundaries to redefine current stand boundaries so that they coincide with management unit boundaries must be done as a data preparation step.

Indices of access can be included in formulas used to compute the priority for selecting stands. These access data may be indexed by time so that the scheduling can be sensitive to changes in a road network. Access data were not included in this example.

Resource Supply Analysis

The PPE can be used to simulate vegetation-related resource supply analysis for a sample of disjunct stands taken from a large area. For example, regional timber supply can be analyzed using the PPE. The approach is to enter treatment probabilities and silvicultural treatments for each sample unit (a surrogate for a sample stand) or for groups of sample units. The harvest probabilities and choice of silviculture may be a function of any information inventoried for the sample units such as ownership and location. Outputs from the PPE can include several measures of the vegetation component of the ecosystem.

Aspects of resource supply analyses and multistand treatment scheduling may be combined in a single PPE run. Groups of contiguous stands can form the sample units, and different harvest policies can apply to each group. Several such groups may be entered in one run, and the composite yield over all samples may be produced.

Contagion in Pest-Dynamics Models

The PPE provides a way to simulate the behavior and effects of contagious agents that are sensitive to spatial relationships between stands. To illustrate this capability, we present a multistand mountain pine beetle (MPB, *Dendroctonus ponderosae* Hopkins) model for contiguous areas. Note that a western spruce budworm (*Choristoneura occidentalis* Freeman) model also contains contagion relations (Crookston and others 1990; Sheehan and others 1989). Likewise, a Douglas-fir tussock moth (*Orgyia pseudotsugata* [McDunnough]) model could take advantage of the PPE to fully utilize reported results on the spread of tussock moth (Monserud and Crookston 1982).

Description of the Mountain Pine Beetle Model—This multistand MPB model simulates MPB spread and damage to lodgepole pine in nearby

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or contiguous stands. The rate-of-loss model described by Cole and McGregor (1983) is used to compute number of trees killed within each stand for each year of the simulated outbreak. Units of "kill pressure" (dead basal area per acre is used as a measure of MPB population) are spread between stands using an algorithmic model. The algorithm depends on the within-stand lodgepole phloem volume, currently killed basal area, and the total wood volume, and the distance and length of common boundary between stands.

An Example Using the MPB Model—This example is taken from an area in the Trapper Creek Quadrangle in the Nez Perce National Forest, ID. Figure 2 displays two "spread" maps produced by running this model. Map 1 illustrates what happened during the second year of the outbreak and map 2 shows the area 7 years after the outbreak. The maps were produced by combining the output of the PPE with map data.

Map 1 Polygon fill	MPB-killed ft³/acre
Dotted lines, empty polygons	0
Solid lines, empty polygons	0 to 10
Large vertical hatching	10 to 30
Horizontal hatching	30 to 80
Solid polygons	over 80

Map 2 Polygon fill	MPB-killed ft³/acre
Dotted lines, empty polygons	0
Solid lines, empty polygons	0 to 80
Large vertical hatching	80 to 1,000
Horizontal hatching	1,000 to 3,000
Solid polygons	over 3,000

Figure 2—Map 1 shows simulated MPB-killed ft³/acre for the second year of an outbreak, and map 2 displays the seventh year. Example is from the Trapper Creek Quadrangle, Nez Perce National Forest, ID.

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The output maps illustrate a concern regarding the use of stands as geographic units in forest simulation (see the harvest simulation discussion for the first concern). MPB conditions within long and skinny stands—such as those that follow streams or roads—are not consistent throughout the stand. Because stand boundaries define the spatial resolution of the simulations, the model cannot differentiate between MPB conditions in one part of the stand versus another. This lack of resolution may be important in severe situations. The problem can be reduced by arbitrarily dividing stands that have long borders relative to area into smaller and more compactly shaped units.

An important feature of the data required by this model is that all of the area in the MPB-infested region needs to be included regardless of ownership or administrative authority. The MPB ignore these boundaries!

Multistand treatment scheduling and contagion can be mixed in the same run if only one multistand policy is specified or if a hierarchy of two policies is specified. When more than one multistand policy is simulated, the PPE creates replicates of individual stands and simulates each replicate according to different management regimes. The present version of the PPE does not contain necessary logic to simulate more than one policy when a contagion model is included.

The idea of creating replicates of stands so that each replicate can be run using different management options leads to a general discussion of decision trees.

Introduction to Decision Trees

Forest managers and silviculturists often wish to simulate the outcome of several management options before choosing a plan. For individual stands, the Prognosis Model may be used for this purpose by making several runs, each run differing by timing, intensity of management, or both. The model answers "what if..." questions such as:

A. What if we thin to 300 trees/acre in 20 years?
B. What if we wait for 40 years before thinning?
C. What if we don't thin at all?

Figure 3 contains a schematic of a decision tree that illustrates these three options. To compare these three options using the Prognosis Model without the PPE would require three Prognosis Model runs. Note that the computations required for all three options are identical for the first 20 years, and options B and C share identical computations for the first 40 years. This duplication of computation becomes significant when many stands or branches are being processed. The computing problem can be solved using the following steps:

1. Simulate the stand up to year 20 and store all data.
2. Simulate growth from year 20 to year 40 according to the "thin" option and store the "thinned" stand.
3. Retrieve the data as stored for year 20, before thinning.
4. Simulate the "no-thin" stand up to year 40 and store this version of the stand's data.
5. Retrieve the thinned stand's data and simulate its growth from year 40 to year 60. This completes outcome 1.
6. Retrieve the "no-thin" stand's data stored at step 4. Thin the stand and simulate its growth from year 40 to 60. This completes outcome 2.
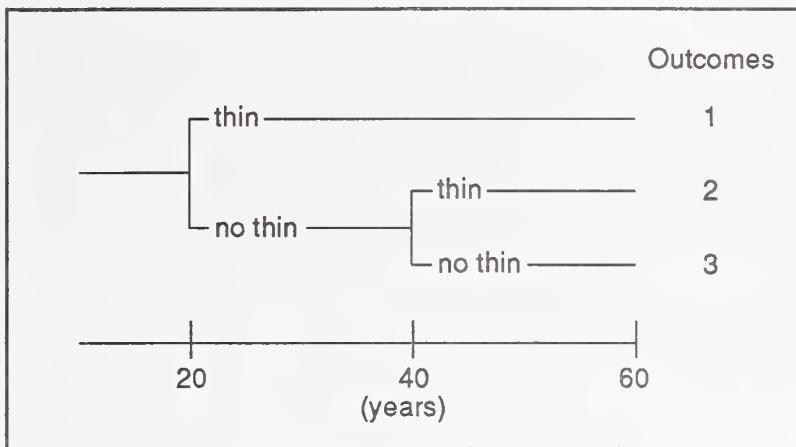
Figure 3—Decision tree illustrating three management options.

7. Again retrieve the "no-thin" data stored at step 4. Simulate its growth from year 40 to 60 to complete outcome 3.

The PPE simulates the decision tree illustrated in figure 3 using the logic outlined in these seven steps.

Introduction to Policy Evaluation

A policy can be expressed by stating the actions that will be taken if and when a specific situation exists (Crookston 1985, 1990). In forest management, a policy might be to intensively manage an area. Intensive timber management might be defined as thinning stands that are overstocked and harvesting stands when they reach some specific standards of size and maturity. Harvested stands would be regenerated by preparing the site and planting areas that do not naturally reach full stocking within a few years.

Stand management policy statements in the Prognosis Model are composed of three elements. The first element is a logical expression that states the circumstances for treatment. The second is a set of activities that will be scheduled when the circumstances exist. The last element is the name of the policy.

Policy Labels—A policy of thinning stands that are overstocked can be identified by a name or label such as *intensive management*. Two or more statements of circumstances and activities may be part of the same policy. If so, they are labeled with the same policy label. For example, the logical expression that detects the condition "overstocked" is followed by a set of Prognosis Model thinning options that represent the thinning activities. If intensive management includes the harvest activities that are scheduled when the stand reaches maturity, it makes sense to label the harvest activities with *intensive management* as well.

In addition to labeling logical expressions and groups of activities, you also label each stand with a label identifying the policies under which the stand is to be managed. If a stand is to be managed under *intensive management*, it would be given this policy label.

During the simulation, the Prognosis Model monitors conditions within the stand by testing the value of the logical expressions. If the expression is true, the activities may be scheduled. If the stand label set does not contain any of the labels specified for the activities, the activities are not scheduled.

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We have defined two sets of labels. The label set attached to logical expressions and activities is called an *activity group label set*, and the label set attached to stands is called the *stand label set*. The reason for adding the word *set* to the end of each name is easily illustrated with an example. Let's say that we have two stands; the first is to be managed under intensive management and the second under extensive management. The harvest activities for both intensive and extensive management are identical. The only difference between the two regimes concerns the application of precommercial thinning activities. The logical expression and activities that describe the harvest receive the activity group label set {*intensive management*, *extensive management*} while the precommercial thinning policy receives the activity group label set {*intensive management*}. The stand label sets contain one label each, {*intensive management*} for the first stand and {*extensive management*} for the second.

One way to use this facility is to specify all of the policies that apply to your stands by stating the conditions and actions that are appropriate. Give each a policy name; the same name may apply to more than one condition and action statement. Then, go through all of the stands in the run and label each by the policies that are appropriate for it.

Contrasted Policies—You can use the policy labeling scheme and the PPE's ability to generate decision trees together. For example, assume a pest manager wishes to contrast the effect of *always spraying pests* when pest outbreaks occur versus *never spraying pests* (fig. 4). Spraying pests or not spraying the pests are the two alternative policies that are contrasted over the length of the simulation. No matter how many pest outbreaks occur, only one node and two branches of a decision tree are created. Spraying is applied every time a pest outbreak occurs along one of the branches of the decision tree, and no spraying is done on the other branch of the decision tree.

Several Possible Timings—Consider the problem of simulating several thinning schedules for a single stand. A decision rule to thin a stand that is too dense is one alternative, and postponing the thinning is the other.
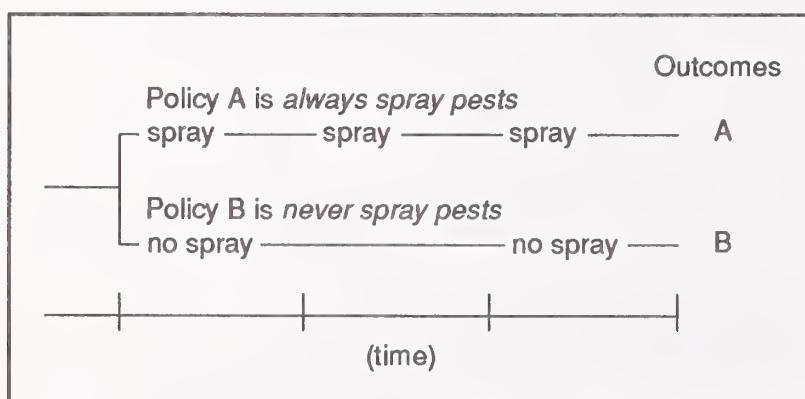
Figure 4—A contrasted policy will generate one node and two branches of a decision tree. In this example, the policy of *always spraying pests* resulted in three pest outbreaks and three spray activities; only two outbreaks occurred with *never spray pests* policy.

Figure 5 is a decision tree that illustrates this example. Note that the decision tree is labeled with the activities that are scheduled for each branch; it is not labeled with policies. The policy label for this example could be *intensive* for all of the branches. All 13 outcomes are appropriate for intensive management; they differ only by the timings of the activities. Dynamic programming or some other method could be used to choose which of the 13 outcomes to follow.

The decision tree in figure 5 is a realistic and hypothetical outcome that could be realized when applying the thin and postpone thin rules stated above. In this example, thinning removes the need for thinning for two decades so another branch is not created in the decade following thinning. When the stand is not thinned, a branch is created in the following decade.

The most important point of this example is that it demonstrates how the policy labeling scheme can produce different results by making a simple change in the policy label sets. To create a contrasted policy, each activity group is labeled with a unique label set. To create several possible timings, each activity group is labeled with the same label set or with sets that contain at least one member label in common.

Relationship Between Multistand and Stand Policies—The relationship between multistand and stand policy label sets is similar to the relationship between the stand and activity group label sets. The stand policy label set must contain the multistand policy label for the stand to be managed under the multistand policy.
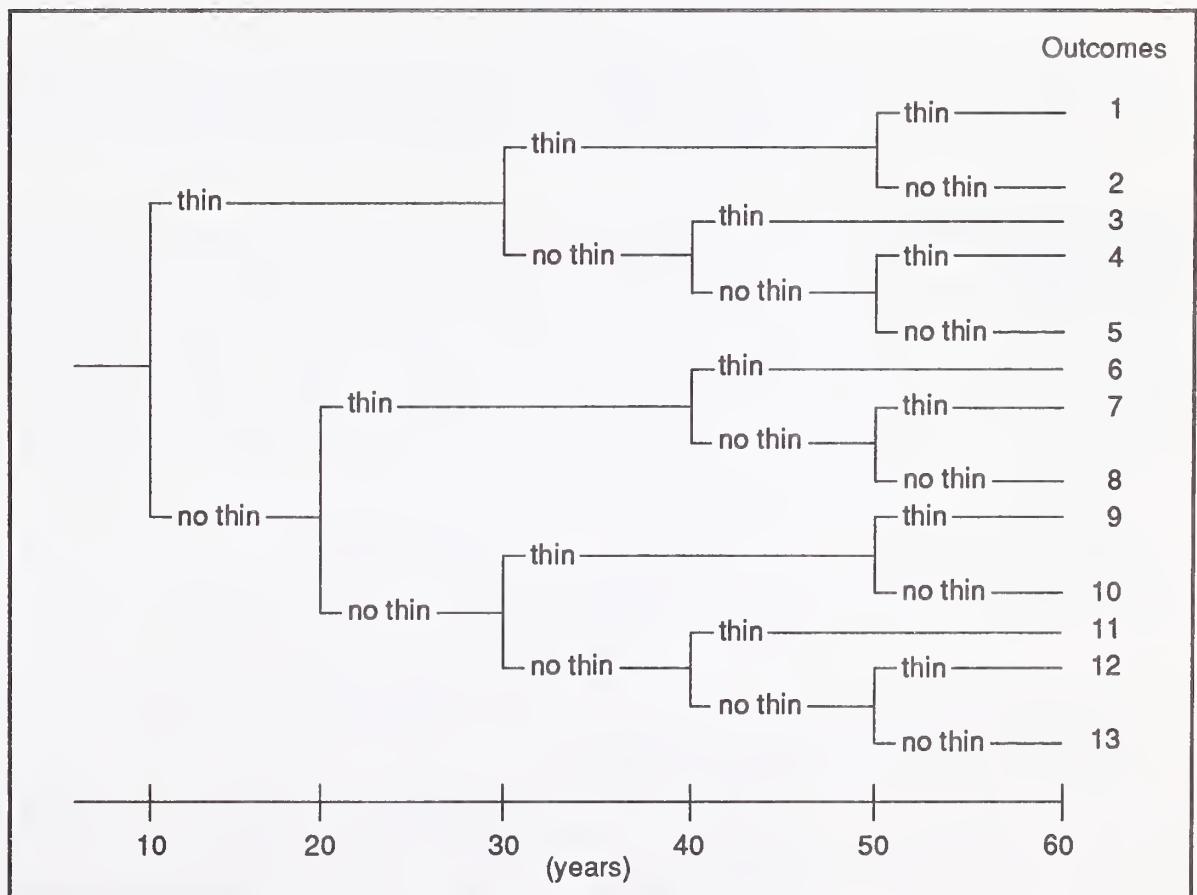
Figure 5—A decision tree that illustrates a *several possible timings* problem.

In the example of multistand treatment scheduling, two multistand policies were specified, one was labeled *cover* and the other *timber*. Each stand was labeled with the stand policy label set {*cover, timber*}. There were stand management policies that applied when stands were managed for cover and other policies that applied when stands were managed for timber. These stand management policies carried corresponding activity group policy labels. The example was run as a hierarchy of two policies. When a stand was needed for cover, the stand policy label set was temporally changed by the model by deleting the label *timber*. When the stand was not needed for cover, the timber label was placed back into the stand label set.

A different logic is used when two or more multistand treatment policies are run without the hierarchy feature. For example, suppose we have multistand treatment policies that are identical to the *no cover required* alternative, except that the second alternative calls for harvesting the formula cut every decade rather than doubling the formula for two decades followed by zero harvesting for two decades. The label for the first alternative could be *timber.pulse* and for the second it could be *timber.continuous*. The multistand treatment policy labels can have two parts, separated by a period. The first part, *timber*, in this case, is the part that must be present in the stand label sets for every stand that is managed under the *timber* multistand policy. If a stand's yield is needed to meet the target of *timber.pulse* and not for *timber.continuous*, the stand is replicated. One replicate is harvested and the other is not. That portion of the multistand policy label that follows the period is used to create unique multistand policies in cases where the stand management is the same for several different multi-stand policies.

The process of creating replicates of stands when simulating alternative harvest schedules is like the process of creating decision trees for simulating alternative stand management policies.

Expected Value Outcomes

In addition to representing management alternatives, the nodes of decision trees can also represent random events of nature. Each branch of the decision tree simulates the alternatives of experiencing the random event versus not experiencing the event. The branches of the decision tree are weighted by the probabilities of experiencing the events represented by the branch. The expected value is the weighted average of the decision tree branches.

For example, the expected yield of a stand that might be partly or completely destroyed by fire could be computed using expected value outcomes (fig. 6). The probability of fire occurrence becomes the weight associated with the *fire* branches. The damage caused and the stand's response to being burned would be simulated by the model. Another branch that represents the *no fire* outcome would be weighted with the complement of the *fire* probability.

Decision trees that represent random events are generated using essentially the same methods as used to represent alternative policies, or the *several possible timings* example illustrated in figure 5. The only difference concerns the use of a probability factor to weigh the outcomes rather than using the stand size or sampling probability as would be appropriate for the decision trees that represent alternative policies. This difference does not influence calculations within the PPE except the computation of
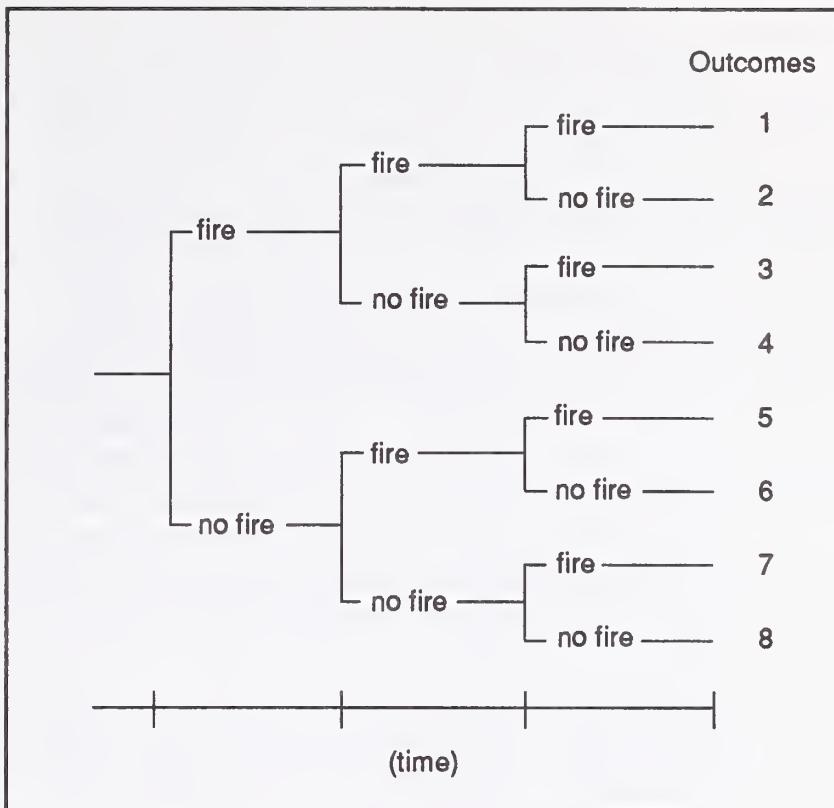
Figure 6—Fires occur as random events with probability p, and do not occur with probability $1-p$. Each branch of the decision tree is appropriately weighted by the probabilities of fire or no fire.

the weighting factors used to compute composite yield statistics. Because the differences between the kinds of decision trees do not affect other PPE computations, both kinds of decision trees can be mixed in the same run.

Composite Yield Statistics

The PPE can produce a composite yield stream for all or a subset of the stands projected as a group (fig. 7). The composite yield statistics are computed by taking a weighted average for the stands that are included in the composite. The weights used in the computation are the product of two values. The first value is either the sampling probability specified for each stand or the area of the stand. The second value is the branch weight, which is assumed to be 1.0 for each stand unless it is explicitly changed using a PPE option. For example, the appropriate weight for outcome 2 in figure 6 is the product of the probability of fire at the first node, times the probability of fire at the second node, times the probability of no fire at the third node, times the stand size or sampling probability.

When policy labels are used, they can be employed to define groups of stands that make up composite yield tables. The calculation of expected values can be combined with the calculation of composite yields for each alternative management policy.

The data elements of the composite yield statistics output are fully described on page 17.

Controlling Simulation Costs

The costs of simulating several hundred stands in parallel, including interstand interactions and policy analysis, could easily become prohibitive. There are several ways to reduce the cost of operating the PPE:

1. When solving an expected value branching problem with many stands, simulate only one branch at each node for each stand, with the choice of which branch depending on relationship between the probability of the random event and a random number.

2. The program should update state variables applicable to each component of the system only when it is necessary. For example, when an insect population is not above endemic levels, the state variables defining the population may not need to be incremented for time steps as short as those needed to represent high populations. Prognosis Model extensions that represent insect pests include features that let you control how often and for how many years the pest models run.

3. Limit the number of model extensions to only those that require dynamic interaction. If the predictions made by submodels that represent ecosystem components other than vegetation do not influence the growth or management of vegetation, then the submodels do not need to be dynamically linked. In cases where the predictions of these submodels do influence the growth or management of vegetation, the models might require dynamic linkages. For example, say you are simulating the harvest on a third-order watershed. A streamflow model is used to simulate the effects of the harvest activity on such factors as sediment loads. The results of the stream flow model may act to restrain the harvest in a predetermined way, not requiring that the stand model and the stream model be run jointly. Existing Prognosis Model extensions have been written with this concept in mind.

4. Suppress unnecessary output or defer printing until the need is evident. The PPE writes the Prognosis Model output in a retrievable format to a direct access file; after the run, you may request that certain tables be printed.

5. The PPE has a pause-and-restart facility so that intermediate results can be viewed and problems detected before a large amount of computer time is expended.

COMPOSITE YIELD STATISTICS

YEAR	AGE	VOLUME PER ACRE				REMOVALS/TREATED ACRE				BA/ACRE SQFT	CCF	AVE DOM HT FT	GROWTH			TOTAL SAMPLE WEIGHT	FRACTION OF AREA TREATED	MGMT ID
		TREES /ACRE	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES /ACRE	TOTAL CU FT	MERCH CU FT	MERCH BD FT				PRD YRS	ACC CUFT/YR	MOR			
1981	0	1711	2327	1706	7031	0	0	0	0	81	95	54	9	76	33	511	.000000	HVP2
1982	0	1590	113	32	132	0	0	0	0	12	17	20	8	65	0	262	.000000	HVP2
1983	0	795	596	524	2260	0	0	0	0	28	34	54	7	36	0	69	.000000	HVP2
1984	0	2100	5296	4601	19390	0	0	0	0	154	171	84	6	111	60	839	.000000	HVP2
1985	0	2564	5669	4783	21907	0	0	0	0	175	199	90	5	130	61	1585	.000000	HVP2
1990	6	1771	4850	4093	18369	1178	8559	7751	36122	121	142	73	10	90	46	3266	.132884	HVP2
2000	15	1174	4155	3500	15871	780	4213	3883	19648	118	137	69	10	88	41	3266	.128904	HVP2
2010	24	900	4076	3491	15731	203	443	432	2295	128	147	68	10	92	49	3266	.094917	HVP2
2020	33	705	4462	3945	17948	202	289	269	1431	138	155	74	10	101	55	3266	.017759	HVP2
2030	43	546	4924	4400	20343	510	7150	6746	33691	128	142	73	10	98	51	3266	.122780	HVP2
2040	49	464	4520	4063	18689	316	4846	4592	22274	121	132	69	10	91	46	3266	.156461	HVP2
2050	53	459	4212	3838	17628	360	500	485	2678	131	141	70	10	97	50	3266	.086344	HVP2
2060	62	407	4637	4289	19970	270	209	199	1084	142	150	76	10	105	54	3266	.076852	HVP2
2070	72	331	5131	4770	22530	217	6063	5759	28773	125	132	74	10	93	46	3266	.178200	HVP2
2080	69	336	4525	4206	19808	234	3769	3527	16157	110	113	69	10	82	40	3266	.208512	HVP2
2090	67	402	4159	3889	18589	58	483	461	2432	119	122	68	10	87	44	3266	.120025	HVP2
2100	76	416	4534	4266	20539	559	140	125	676	130	132	75	10	98	47	3266	.098285	HVP2
2110	86	314	5024	4708	22900	0	0	0	0	144	145	83	0	0	0	3266	.000000	HVP2

Figure 7—Composite yield statistics table created by the PPE.

HOW THE PPE WORKS

This section describes how the PPE accomplishes tasks. The following topics are covered:

1. The steps completed in a PPE run are described. This general description provides you with information on how the capabilities of the system come about.

2. The output generated by the PPE is introduced. Most of the output available using the PPE is actually produced by the Prognosis Model or other models linked to the PPE. How Prognosis Model output is organized by the PPE is described.

3. How time increments (or cycle length and number) are specified for individual stands and reconciled with those specified for all of the stands is described.

4. Decision trees are used by the program as a tool for solving problems. An introduction to decision trees is provided as background to subsequent discussions.

5. The algorithms used in processing policy labels are described. Policy evaluation makes heavy use of decision tree generation and, conversely, policy label processing often determines how decision trees are formed.

6. How composite yield statistics are computed is described. Policy label processing and decision trees influence composite yield statistic generation.

7. The logic used to simulate multistand treatments is covered next because it uses policy labels, decision trees, and composite yield statistic generation as tools.

8. The logical flow of the PPE is described.

Steps in a PPE Run

In general terms, a run of the PPE includes the following steps:

1. You enter PPE options and program-control commands. One of the PPE commands establishes a starting date for the multistand projection, called the master starting year. Another establishes cycle intervals common to all of the stands in the run. These cycles are called master cycles.

2. You enter Prognosis Model options and tree data for one stand. The stand is processed serially by the Prognosis Model up to the master starting year. This processing may require that only the initialization processing done by the Prognosis Model be executed, or it may require one or more Prognosis Model cycles. Then the stand data are written on a disk file. This step is repeated for all of the stands in the run.

3. The PPE reviews the status of all the stands and can modify options that control the simulation of any one or all stands. The time steps of a stand can be changed to ensure that within-cycle stand interactions can be simulated. If a stand has been selected for treatment under a multistand treatment policy, the treatment schedule for the stand may be changed.

4. The PPE increments its time increment (or cycle) counter.

5. Each stand's development is simulated from the beginning through the end of the current master cycle. This period may require one or more Prognosis Model cycles for each stand. If a decision tree is called for, a decision-tree node is created and the branches are simulated.

6. If the last master cycle is complete, the PPE proceeds to the reporting step 7; otherwise steps 3 through 5 are repeated.

7. You enter PPE commands necessary to process and print desired yield or stand tables and other output.

Output

Output created by the PPE includes the output produced by the Prognosis Model and the extensions that are being used in the run. However, in the PPE you have control over which Prognosis Model tables are output and when they are produced. In addition to Prognosis Model output, the PPE produces informative messages concerning the operation of the program. Additional reports include the composite yield statistics table. Output from multistand treatment scheduling and policy label processing are described in their respective sections.

Prognosis Model Output—The Prognosis Model produces six tables that describe the results of the simulation for each stand:

1. The input summary and calibration statistics table lists the run options and the results of the model's self-calibration process (see fig. 6 in Wykoff and others 1982).

2. Stand composition table lists the tree composition of the stand at each time interval and the composition of the population growing, dying, and being removed via management action (see fig. 7 in Wykoff and others 1982).

3. Sample tree records-stand attribute table lists the attributes of six sample trees and attributes of the stand such as average diameter at breast height (d.b.h.) and total basal area. This information is printed once for each growth cycle (see fig. 8 in Wykoff and others 1982).

4. Summary statistics table contains one line for each cycle in the simulation. Elements include descriptions of tree removals, growth, mortality, stocking, and stand identification (see top of fig. 9 in Wykoff and others 1982).

5. Activity summary table contains a list of the activities (options) scheduled for the stand and their disposition (see the bottom of fig. 9 in Wykoff and others 1982).

6. Tree list output (fig. 21 in Wykoff and others 1982) contains a listing of most attributes of all of the tree records that represent the stand.

The PPE Data Files—The data that comprise most of the tables listed above are stored within the PPE file system. (The input summary and calibration statistics tables and tree list data are produced immediately.) The PPE file system is made up of three files. The first is called the all-data file; it is a direct access file containing the individual tree data, stand data, summary statistics data, and other data needed to represent each stand. The second is called the print-data file; it is also a direct access file, but it contains only the data elements that make up the stand composition and sample tree records-stand attribute tables. The third is a sequential file called the simulation history file that contains the data needed to access the print-data file.

At the end of a projection, these data files can be recalled and the normally produced Prognosis Model output can be printed. However, you control the organization of the output and the selection of stands and tables to be printed. If these files are retained after a run of PPE terminates, then further output processing can be done in a later run.

Composite Yield Statistics Output—The composite yields are computed by taking a weighted average of the corresponding data elements from each stand. For example, the composite trees per acre is the weighted average trees per acre over the stands that make up the composite.

The weights used in computing the composite are equal to the PPE stand weighting factors. The weighting factors are the product of two values. The first value is either the inverse of the sampling probability as specified on the DESIGN keyword record for each stand or the area of the stand as defined by reading stand area data for all stands (see the AREALOCS option on page 53). If the area data are specified, the area is used as the first value. If they are not specified, the sampling probability is used. The second value is the branch weight. The branch weight is 1.0 for each stand unless it is explicitly changed using a THEN and ALSOTRY option described on page 42. You control how these weights are derived, and you must be able to interpret them.

The composite yield statistics table (fig. 7) produced by the PPE is similar to the summary statistics table produced by the Prognosis Model. Attributes of the table are listed below:

1. The composite contains a row for each unique cycle year in the simulation. For example, if there are 20 stands represented in one run, and only one of those stands contained a cycle starting in year 2001, there would be an entry in the composite for that one year for one stand.

2. The total weight for one row is the sum of the PPE stand weighting factors for all of the stands represented in the row. The sum will be equal for all rows if the cycle years are the same for all stands.

3. The fraction of area treated is the sum of the PPE stand weighting factors for just those stands that were treated (harvested) during the year divided by the total sample weight.

4. Age, crown competition factor (CCF, Krajicek and others 1961), trees per acre, volumes per acre, basal area per acre, average top height, and the growth period are weighted averages for the stands included in the row.

5. Removal volume per treated acre is the weighted average for the treated (harvested) area.

6. The total number of trees, basal area, or the total volumes may be found by multiplying the attribute of interest by the total sample weight listed for the row.

7. If the total sample weight is in units of acres, the total number of treated acres is the product of the fraction of area treated and the total sample weight.

8. The removal volume may be found by multiplying the attribute of interest by the product computed in 7, above.

9. You can specify the management identification field for each composite yield table.

Policy Label Output—Policy labels are printed just above the summary statistics table to which they apply. If a single yield table represents more than one policy, then both labels are printed. For example, if *always spray bugs* and *never spray bugs* turn out the same because there is no occasion for spraying, then one yield table represents both policies and following is printed: STAND POLICIES: ALWAYS SPRAY BUGS, NEVER SPRAY BUGS.

Machine Readable Output—Two machine readable files are routinely available through the PPE. Others are available through the Prognosis Model or extensions or both. Examples of the latter include CHEAPOII (Horn and others 1986) and COVER (Moeur 1985) files; the formats for these files are described in appendix B.

The summary output and composite yield tables can be written without headings. The format of these tables is the same as the printed versions except that the summary output file includes a header record when it is written without headings and the composite yield table output does not contain a header record.

A labels and weights file is produced by the PPE. This file is designed to supply a list of the policy labels, PPE stand weighting factors, and the activities that were accomplished during a run in a machine readable format for processing by other programs. See appendix B for this file's format.

Time Increments

Prognosis Model Time Increments—The Prognosis Model allows you to specify inventory year, the number of time increments, and the length of each time increment (cycle). The recommended 10-year-long cycles are usually used. However, different length cycles can be used. For example, short initial cycles are often used to reconcile the cycling dates of stands inventoried in different years.

PPE Time Increments—PPE time increments are similar to Prognosis Model time increments. You enter the master starting year for the PPE projection, the number of PPE time increments, and the length of each PPE time increment (master cycle). The master starting year is the first year of the PPE's master cycles. It can be any year as long as it is greater than or equal to the inventory year of the most recently inventoried stand in the run.

Master cycles are the PPE's own time increments. That is, the PPE performs functions common to all stands on master cycle intervals. For example, multistand treatment scheduling is run on master cycle intervals. Pest models that include contagious components run within master cycles. Master cycle intervals are common to all of the stands in the run. Several Prognosis Model cycles can be contained within one PPE master cycle and master cycles may be any length, but Prognosis Model cycles cannot be longer than corresponding master cycles.

Annual Interaction—Extensions to the PPE that represent contagious agents update the status of each stand on more frequent time intervals than master cycles. For example, the MPB model described on page 7 simulates between-stand dispersal annually. Note that the MPB model does not modify the Prognosis Model sample trees statistics on an annual basis. It operates on an abstraction of these data and modifies the Prognosis Model tree data only on master cycles. When "annual interactions" are simulated, all of the stands must cycle exactly once during the master cycle. The differences between master cycles that allow for annual interactions required by the MPB model and master cycles that do not allow for such interactions are more completely illustrated in the section describing the PPE's logical flow, page 28.

Reconciling Time Increments—The PPE reconciles differences between Prognosis Model cycles and PPE cycles. Prognosis Model cycles are added to the beginning of a projection as needed to simulate growth up to the master starting year. The length and number of Prognosis Model cycles are modified by a combination of inserting cycles and deleting cycles as needed to completely coordinate the Prognosis Model with the PPE. Study figure 8 to see how the cycling for two stands is reconciled with master cycles.

Stand 1 cycles:	1	2	3	4	5	6
Stand 2 before adjustment:	1	2	3	4	5	6
Stand 2 after adjustment:	1	2	3	4	5	
Master cycles:		1		2		3
Master cycle type:		normal		normal		inter-action

| 1980 | 1990 | 2000 | 2010 | 2020 | 2030 |

(years)
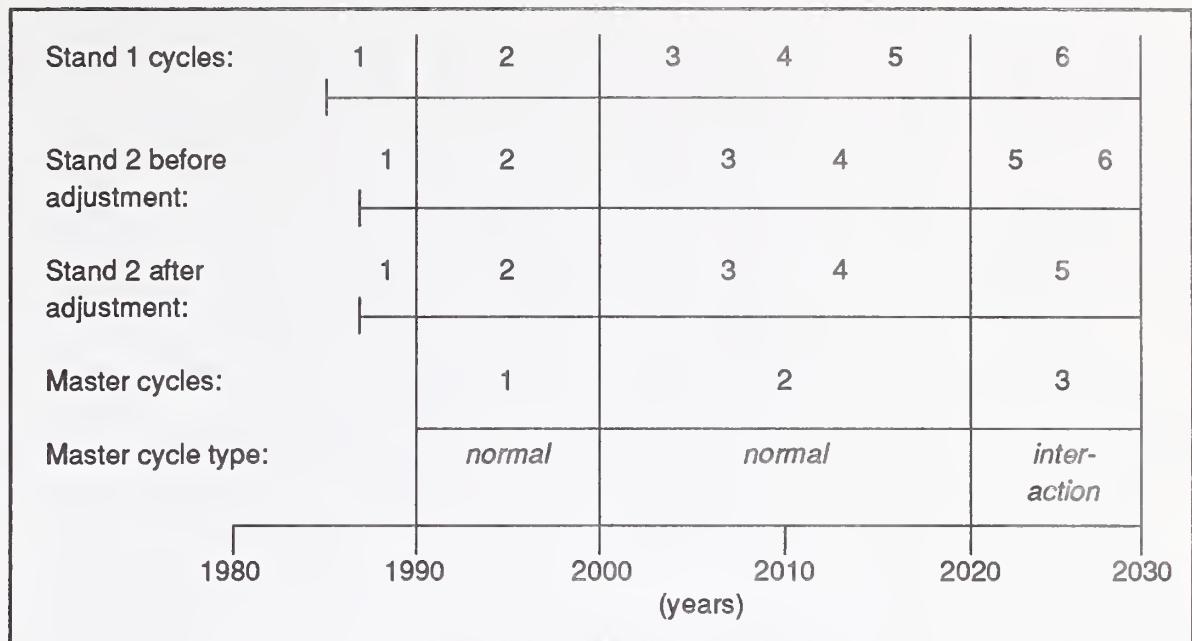
Figure 8—Possible cycle logic. Stand 1 starts in 1985 and stand 2 starts in 1987. The number and length of cycles for stands is automatically adjusted such that (1) stands are simulated up to the master starting year (1990, in this case), (2) stands contain cycles that correspond to the master cycle boundaries (1990, 2000, 2020, and 2030), and (3) each stand will cycle exactly once during master cycles that contain "annual interactions."

Creating Decision Trees

Decision trees are created by the PPE in two cases. In the first case, the Prognosis Model's Event Monitor (Crookston 1990) and policy label processing logic control the creation of decision trees. In the second case, multistand treatment scheduling controls creation of decision tree branches. The PPE keeps track of decision tree branches by modifying an internal stand number (ISN) carried with each stand. Creation of decision trees using the Event Monitor is described next, and creation of decision trees using the multistand treatment scheduling is described later (see page 27).

The Event Monitor—The Event Monitor is called once at the beginning of each Prognosis Model cycle and once again just after the cutting logic is executed. At each call, the monitor evaluates all of the logical expressions for the stand. For each logical expression that is true, the Event Monitor schedules the associated group of management activities.

If an alternative group of activities is also associated with the logical expression, a decision tree node is created. Each branch of the decision tree corresponds to one alternative activity group.

The Event Monitor interacts with the PPE by "telling" the PPE how many branches are needed to simulate the alternatives. The PPE creates the branches by replicating the stand once for each branch. If there are three alternative activity groups, then the PPE will create three replicates of the stand. One of the activity groups is scheduled for each replicate.

Let's consider the decision tree as diagramed in figure 3 (page 9). When the stand reaches year 20, the Event Monitor finds that the logical expression is true. Two activity groups are conditional upon the logical expression. Therefore, the PPE creates two replicates of the stand. Thinning is scheduled for one of the replicates, and no activities, that is, no thinning, are scheduled for the other.

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The PPE does not consider a stand that has branched any differently than one which has not, except that the ISN is different and the policy labels may be different, as explained below.

Internal Stand Numbers—The PPE's internal stand numbering system is the key to reconstructing and displaying decision trees. For each stand in the run, the PPE assigns an ISN that carries, in coded form, the stand's input sequence number and associated branching scheme. For example, the first stand entered into the PPE is assigned ISN=00010000000; the first four digits represent the input sequence number, the next seven digits represent the branching history. In this case, the last seven digits are zero indicating that the stand has not branched.

Figure 9 contains an example of a stand that has branched once (that is, there is one node) into two branches of a decision tree. The PPE creates these two branches by first duplicating the stand. Then the ISN of the first duplicate is changed to 00011000000, indicating that it represents the first branch of the decision tree, and the ISN for the second is changed to 00012000000, indicating that it represents the second branch.

If the second branch of the decision tree in figure 9 branched again in a later master cycle (in 2010, for example) the ISN's for the new branches would be formed by the PPE by modifying the ISN for the second branch. For example, say that the node created for ISN 00012000000 in 2010 contained three branches. The ISN's for the these three branches would be: 00012100000, 00012200000, and 00012300000.

The stand numbering scheme allows for up to seven nodes (this maximum may be increased). Each node may have up to nine branches; any or all of the stands in a run can branch provided that the maximum number of stands the PPE is set up to hold is not exceeded. This number is installation specific.

Policy Evaluation

Policy evaluation includes computing the amount of a resource that is provided when the resource is managed according to a policy's tenets. An easily understood example comes from timber management. If one stand
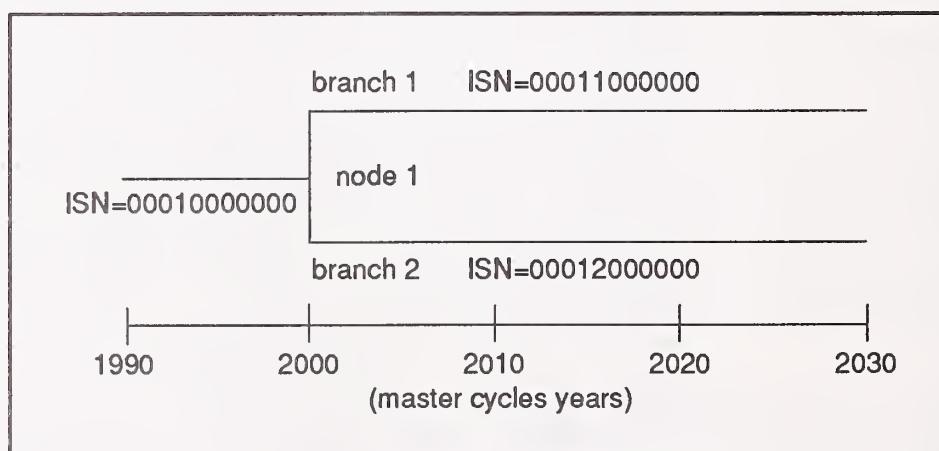
Figure 9—Schematic of a simple dichotomous branch in the PPE. The INS of the stand before it has branched is 00010000000. After it has branched, the ISN's of the stand duplicates are 00011000000 and 00012000000, which indicate that there are one node and two branches.

management policy calls for site preparation and planting, and another policy calls for relying on natural regeneration, then an evaluation of policies includes predicting the growth and yield of stands managed under each. At the stand level, these policy statements are often referred to as prescriptions. In this document, the term "prescription" refers to a *schedule of activities*, whereas a policy additionally refers to a statement of the circumstances that trigger the scheduling of activities. Using these definitions, it is possible to think of stand management policies as well as multistand—watershed or forest level—management policies.

Policy labels play a critical role in policy evaluation by influencing the way the model applies stand-level and multistand management rules. For example, if a stand management policy label is *wildland* and all of the activity groups are labeled *intensive*, the model will not schedule any of the activities, even if all of the logical expressions are true. In this case the stand policy label acts to constrain the scheduling of activities, and this can influence the creation of decision trees. It was pointed out in a preceding section (Introduction to Policy Evaluation, page 9) that small changes in policy labels can result in creating a decision tree that represents a contrasted policy (fig. 4) or a decision tree that represents several possible timings (fig. 5).

Rules for Processing Labels—The PPE uses a set of rules to create decision trees and apply management rules when policy labels are used. Appendix C contains a detailed description of these rules. Understanding the principles behind the rules will serve most peoples' needs.

Principle 1. Each group of activities has an associated set of policy labels called the activity group policy label set (AGPLABEL); a separate set of labels is associated with the stand and is called the stand policy label set (SPLABEL). The default SPLABEL set is the set union of the AGPLABEL sets. Then the SPLABEL set is assigned to activity groups for which no AGPLABEL is specified.

Principle 2. A group of activities cannot be scheduled unless the AGPLABEL set and the SPLABEL set each contain at least one common label.

Principle 3. One branch is created for each unique group of scheduled activities. That is, if the same activities are specified for two or more branches, one branch will usually be used to represent the two or more groups of activities.

Principle 4. When a branch is created, the SPLABEL set for the branch is replaced by the intersection of the SPLABEL set and the AGPLABEL set that corresponds to the branch. If the branch represents two or more activity groups as stated in principle 4, the SPLABEL set for the branch is intersection of the SPLABEL set with the set union of the AGPLABEL sets associated with the activity groups.

Principle 5. If no branching ever occurs, the SPLABEL is never modified. One yield estimate is the correct result for all policies.

Principle 6. A "no action" branch is automatically generated when it is needed to represent policies that would not otherwise be represented.

An Example of Label Processing—For an example of how these principles are followed, consider the schematic commands illustrated in figure 10 (if you are confused by the syntax used in this example, consult Wykoff

Schematic Prognosis Model command (or keyword) file.	English translation

IF
     density GT x
(1) THEN
     thin
     AGPLABEL
     Intensive
(2) ALSOTRY
     nothing (wait)
     AGPLABEL
     intensive
     ENDIF
   IF
     c.a.i. LT m.a.i.
(3) THEN
     harvest and regenerate
     AGPLABEL
     intensive, extensive
(4) ALSOTRY
     noharv (do nothing)
     AGPLABEL
     intensive, extensive, &
     wildland
     ENDIF
	If the density
	is greater than x,
	then (1)
	thin the stand.
	Label this activity as part of
	the {*intensive*} policy. As an
	alternative, also try (2)
	not thinning the stand and
	label this policy
	{intensive} too.
	
	If the stand is mature
	(indicated by culmination
	of m.a.i), then (3)
	harvest and regenerate.
	This activity is appropriate
	for both {*intensive, extensive*}
	management policies. Also try (4)
	not harvesting. This altern-
	ative is appropriate for
	{intensive, extensive,
	wildland} management.

Figure 10—A schematic keyword file segment illustrating the policy labeling scheme needed to generate several possible timings. The parenthetical numbers are for reference only; words shown in lower case must be replaced with commands that accomplish the designated tasks.

and others 1982 and Crookston 1990). Note that figure 10 does not illustrate a complete Prognosis Model or PPE keyword file.

The AGPLABEL command is used to enter policy labels for each activity group. The activity groups are numbered 1 through 4 in figure 10. Consider the policy labels as arbitrary labels; the reasoning behind their choice is not important at this point.

The AGPLABEL sets for this example are as follows:

$AGPLABEL_1 = \{intensive\}$
$AGPLABEL_2 = \{intensive\}$
$AGPLABEL_3 = \{intensive, extensive\}$
$AGPLABEL_4 = \{intensive, extensive, wildland\}$

Under the first principle, the model creates a SPLABEL set by finding the union over AGPLABEL sets defined for the stand. For this stand,

$SPLABEL = \{intensive, extensive, wildland\}$.

For the purposes of this example, assume that both logical expressions are true the first time the expression is evaluated. By principle 2, all four activity groups could create branches because all of them contain at least one label that is also a member of the SPLABEL set.

Activity groups 2 and 4 have identical activities (in this case the reason they are identical groups is that they are both groups without any activities). By principle 3, one of these two potential branches is deleted.

By principle 4, the stand labels for each branch will become the labels from the activity groups that the stand branch represents. For each of the three branches created at the first node, the new stand labels will be as follows:

SPLABEL for branch 1: {*intensive*}
SPLABEL for branch 2: {*intensive, extensive, wildland*}
SPLABEL for branch 3: {*intensive, extensive*}

Figure 11a illustrates the results of processing the first node.

So far, this example illustrates most of the label processing principles. To see the need for the sixth principle, rework the example in figure 10 under the assumption that only the first logical expression is true when the first node is created. You should be able to show that the label sets shown in figure 11b are generated.

Generating Expected Value Outcomes

Generating expected values can be done with or without using policy labels. If SPLABEL and AGPLABEL sets are not specified, branches are created for each alternative group of activities each time the logical expression is true. Therefore, not using policy labels results in decision trees such as the one illustrated in figure 5, page 11.

To compute the expected value outcome, the probability of each outcome must be known. For example, the probability of reaching outcome 1 in figure 6 (page 13) is the probability of having a fire at the first node, times the probability of having another fire at the second node, times the probability of having a third fire at the third node.

The PPE's facility for creating composite yield tables for any set of stands or branches is used to create expected value outcomes. The PPE stand weighting factors are used in computing composite yield streams. The branch weighting factor starts out being equal to 1.0, but when expected values are computed, the current branch weighting factor is multiplied by
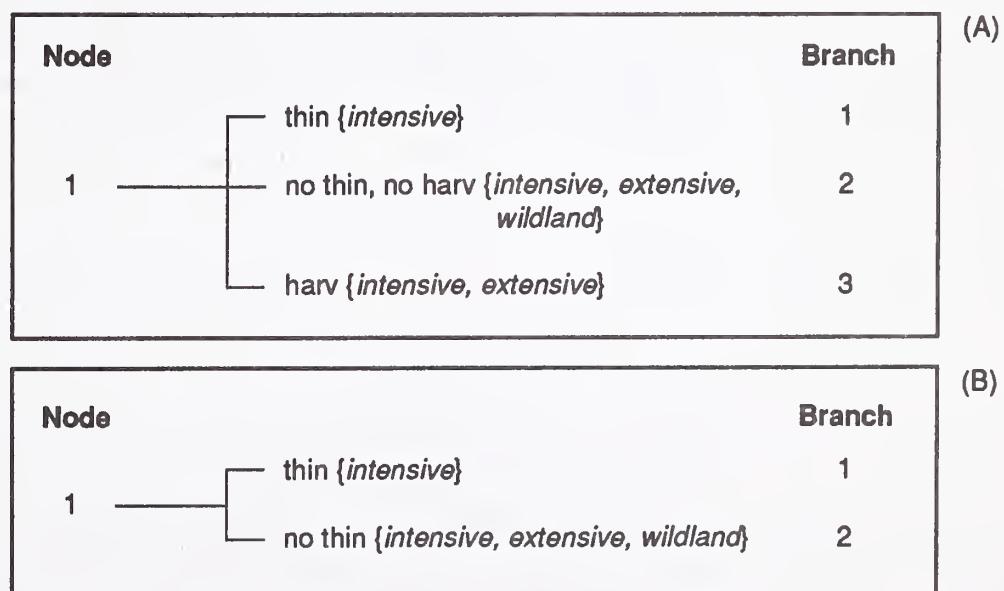
Figure 11—Processing the labels for the example illustrated in figure 13; (A) under the assumption that both logical expressions were true at the same time, and (B) under the assumption that only the first logical expression is true when the first node is created.

the probability of following the branch. In cases where two branches are created, one representing the occurrence of an event and the other representing the event not occurring, then the branch weighting factor corresponding to the branch that represents the event occurring is multiplied by the probability of the event. The branch weighting factor for the branch that represents the event not occurring is multiplied by 1.0 minus the probability of the event occurring.

Therefore, generating expected values simply involves creating a composite yield statistics table. The stands that make up the composite are the decision tree branches from a tree such as the one in figure 6. You control the generation of composite yield tables using commands (described under Using the PPE) that indicate which stands and branches are included.

The branch weighting factor is modified when a node is created. Using procedures described under "Using the PPE," you specify probabilities of following each branch by entering an expression of stand state variables and constants.

Multistand Treatment Scheduling

The PPE can simulate the process of scheduling treatments among many stands. Stands are selected for treatment by computing a selection priority for each stand and then selecting stands in descending order of priority until a target amount of resource is reached. The priority for selection is recomputed each cycle and depends on a function of current stand attributes, accessibility, and constants that you specify. You also specify a formula for the target as a function of composite statistics and constants. Stands may be constrained from being selected for treatment in cases where the treatment, for example a regeneration cut, would create a clearcut that is larger than a maximum you specify. In addition, stands may be associated with one another by forming coordinated management units. If a stand in a coordinated management unit is selected, other stands in the unit are considered for selection prior to selecting stands outside the unit.

You specify stand-level treatments, such as harvest and regeneration activities, conditionally on the value of a stand state variable called SELECTED. For example, you may enter commands that are interpreted as follows: If SELECTED equals YES then THINABA (thin from above to a basal area target) to a target of zero square feet, pile and burn the slash, and plant. Of course, other options may be used instead, and the logical expression may test on several other statistics besides the value of SELECTED.

Each target and priority scheme is called a multistand treatment policy. Up to 15 different multistand treatment policies can be specified in a single run. Up to nine different stand-level treatments (groups of activities) may be specified for each stand conditionally upon the stand being selected or not selected. One stand-level treatment schedule may apply to one or more multistand treatment policies. If a stand is selected to meet the multistand treatment policy target of one or more policies and not selected for some others, the stand is replicated. For one of the replicates, the value of SELECTED is set equal to YES, and for the other it is set equal to NO.

A hierarchy of two multistand treatment policies may be specified rather than several independent policies. When a hierarchy is used, stands are first selected to meet the target of the first policy, and then the PPE selects stands to meet the second policy from the stands that were not selected to meet the first. This feature of the model was used in preparing the multistand treatment scheduling example on page 3.

Computing the Treatment Schedules—At the beginning of a master cycle, the multistand treatment scheduling logic computes the priorities and targets for each policy and then identifies the stands that are needed to meet the targets. This is done by simulating at least two trial runs for each stand. In the first trial, the data representing each stand are restored and value of SELECTED is set to NO. Then the cutting routines in the Prognosis Model are called to simulate treatment activities that are scheduled if the stand is not selected.

Resources removed and resources left after the cutting routines are called are stored, and the data representing the stand are again restored. The value of SELECTED is set equal to YES, and the cutting routines are again called to simulate activities scheduled if the stand is selected. This step is redone for each unique response to the stand being selected. That is, there may be several sets of activities, each labeled with a different AGPLABEL set whereby each applies to a different multistand treatment policy. They are all simulated and the resource data are stored for each.

From these stored data, the priorities and targets are computed, and the stands that are actually needed to meet multistand targets are selected. Each multistand treatment alternative is considered separately. The list of stands is sorted into descending order. The program sets a flag for stands that are selected. The process is to accumulate the resource that is provided by each stand as it is selected and compare the accumulated yield to the target. The selection process stops when the target is reached.

When the maximum clearcut constraint is being used, a more complicated process is followed. If a stand is needed to meet the target, the program checks to see if selecting it would create a clearcut larger than the maximum allowed. This is done by creating a list of all of the clearcut stands that have already been selected for the alternative. The subject stand is added to this list. The program then computes the size of a contiguous clearcut if the subject stand is cut by finding the set of all neighboring stands that are still in a clearcut condition. If the maximum is exceeded, the stand is not selected and a stand of lower priority is tried.

Stands that carry the same management identification code can form a coordinated management unit. A management identification code is a four-character code normally entered for each stand (see LDMGMTID keyword, page 54). If a stand within a coordinated management unit is selected, other stands of lower overall priority that are in the same unit are considered for selection before stands outside the unit are considered. This is done by selecting the stands inside the unit in priority order. If another stand inside the unit is selected, and the maximum clearcut constraint is met, the stand will be selected. If the additional stand is not selected, other stands inside the unit are considered, one at a time, until the unit is exhausted. If one of the additional stands is not selected for any reason, it is placed back in the list with those that are not in the unit. That is, it can be considered again if needed to meet the target.

Sometimes the target is not reached. This can be due to the clearcut constraint causing too many stands to be deferred from treatment or a target that is simply larger than the resource supply. The multistand treatment target can be exceeded when the model selects entire stands. When selecting entire stands, the program selects a stand if over half of the stand is needed to reach a target and does not select a stand if less than half the stand is needed to reach the target. This logic is designed to make the average value of exceeding the target and being below the target equal zero

over the long run. Note that in cases where 100 stands of about the same size are being simulated, using this approach will result in the actual selected resource being within about 0.5 percent of the targeted resource each time period.

An option exists that ensures the targets are exactly met each time period. This option creates a replicate of the last stand selected and multiplies its branch weight by the portion of the stand not needed to exactly meet the target. The original stand's branch weight is multiplied by the portion needed to meet the target, and then it is selected. This option cannot be used when the maximum clearcut constraint is being used because the PPE contains no logic that changes stand boundaries.

Different logic is followed when a hierarchy is used. The logic described above for computing the priorities and targets, the use of coordinated management units, and maximum clearcut sizes is the same. The option that ensures targets are exactly met cannot be used with hierarchies because the stand replication process is not compatible with the hierarchy logic. The difference is that stands not selected to meet the first target form a list of stands that can be selected to meet the second target.

The logic used to process a hierarchy is highly dependent on the use policy labels. A description of this logic is at the end of the next section.

Multistand Policy Labels—Multistand treatment policy labels can contain two parts. The first part of the label is used to relate the multistand treatment policy with the stand policy. The stand label set for every stand that can be managed as part of a multistand treatment policy must contain the first part of the multistand treatment policy label. For example, say that the multistand treatment policy labels (entered using the MSPLABEL command, see Using the PPE) for the first four harvest policies are:

> *intensive.early accelerated*
> *intensive.continuous*
> *intensive.hold now and accelerate later*
> *wildland*

The stands that are eligible to meet any of the first three multistand policy target policies must be given a SPLABEL set that includes *intensive*. If the stands may alternatively meet the wildland policy, their SPLABEL sets must include the two policy labels {*intensive, wildland*}.

If a SPLABEL set does not contain the label for a given multistand policy, the stand is not included in the multistand policy. That is, the stand's resources are not included when the PPE computes target values as functions of overall average conditions and acres for these stands are not included in total weights for the targets. An example for this case would be a stand that is in a natural area. It may be important to include in the run because it may contribute to other resource outputs, such as wildlife or sediment, but otherwise is not in the resource base.

If a SPLABEL set for a stand does contain the first part of the MSPLABEL, the stand's resource supply applies to the multistand policy. However, the stand may or may not contribute toward meeting the target depending on the stand policies included for the individual stand and the nature of the target. For example, say that the target is defined as an amount of removed timber. A stand will not provide any timber unless there is a stand management rule that says that the stand will be harvested when it is selected. The SPLABEL set contains the first part of the MSPLABEL, so the

stand is considered part of the resource base for the multistand policy, but no yield is provided toward meeting the target. Consider another example. Say that the target is defined as a number of acres in cover. A stand that is simply in the state of providing cover contributes to meeting the cover target. In this case, being selected implies that cutting trees may be prohibited. Thus, the management rules for the stand should include the necessary prohibitions.

If a stand is selected under more than one policy in given time step, it is replicated once for each *unique* response to being selected. If only one unique response to being selected is specified, a single replicate of a selected stand is used to represent the selected status under several different policies. This technique greatly reduces the number of replicates required to simulate many different multistand policies.

The model keeps track of the stand replicates and their relationship to multistand policies using an algorithm that modifies the stand policy labels. The algorithm is detailed in appendix C. Here, a description of the computing steps is given using examples. Two multistand policies are defined; one carries the label *intensive* and the other *wildland*. A specific stand has a rule for *intensive*, another rule for *wildland*, and a SPLABEL set {*intensive, wildland*}. As long as the stand is not selected under either multistand policy, one replicate is sufficient to represent both policies. Say, for example, that the stand is selected for *intensive* and not for *wildland*. The stand is replicated and the stand policy label set is split. For one replicate, the stand policy label set will be {*intensive*} and for the other it will be {*wildland*}.

For a hierarchy of two multistand policies the processing is like this. Say that the first policy in the hierarchy is labeled *cover* and the second is labeled *timber*, such as in the example described on page 3. In this case, a specific stand has a rule for *cover*, another rule for *timber*, and a SPLABEL set {*cover, timber*}. When the stand is selected for *cover*, the model deletes the label *timber* from the stand's SPLABEL set. The model does not create a replicate. For the period of the master cycle the stand is managed under the *cover* policy. At the beginning of the next master cycle, the model puts the label *timber* back into the SPLABEL set so that the stand can be considered for *timber* in the next time period.

Multistand Treatment Schedule Report—The PPE prints a report for each multistand treatment policy at the beginning of each master cycle. Figure 12 contains part of the report created when running the hierarchy example discussed above. The table indicates which stands were selected, the computed selection priority, and the resource supply. Stands are listed in priority order. The units of measurement associated with each of these values depends on the formulas used to compute them. Because you specify the formulas, the PPE must assume you understand the units of measurement. The column labeled "MGMT" is left blank if the stand's management identification is blank or NONE; otherwise this column is filled in.

The value of "TARGETED RESOURCE" is the sum of the resource supply that is targeted during the current master cycle. "SELECTED RESOURCE" is the sum of the resource supply for the stands actually selected. "NONSE-LECTED RESOURCE SUPPLY" is the amount of resource available without being selected. When a hierarchy is being simulated, only selected resource is credited toward meeting the target of the first policy. Nonselected

STDIDENT	MGMT	PRIORITY	CREDIT	SELECT	STDIDENT	MGMT	PRIORITY	CREDIT	SELECT	STDIDENT	MGMT	PRIORITY	CREDIT	SELECT
51108068		.6678E+01	.3400E+02	YES	51107053		.2448E+01	.3000E+02	YES	51108089		.2266E+01	.3400E+02	YES
51108091		.1730E+01	.4700E+02	YES	51107065		.1618E+01	.2500E+02	YES	51108052		.1576E+01	.1800E+02	YES
51108002		.1452E+01	.2700E+02	YES	51108078		.1348E+01	.3800E+02	YES	51108050		.1268E+01	.4000E+02	YES
51107059		.1238E+01	.1800E+02	YES	51107005		.6888E+00	.1800E+02	YES	51107057		.6638E+00	.1400E+02	YES
51108087		.6379E+00	.3900E+02	YES	51107080		.5810E+00	.1300E+02	YES	51108062		.5693E+00	.5000E+01	YES
51108094		.4435E+00	.4000E+01	YES	51107091		.3988E+00	.1700E+02	YES	51107078		.3862E+00	.1500E+02	YES
51108061		.3003E+00	.4000E+02	YES	51107008		.1858E+00	.6000E+01	YES	51108083		.1858E+00	.3100E+02	YES
51107009		.1858E+00	.1200E+02	YES	51107052		-.1640E-01	.0000E+00	NO	51108085		-.1666E-01	.0000E+00	NO
51108056		-.1668E-01	.0000E+00	NO	51108003		-.1790E-01	.0000E+00	NO	51108004		-.1790E-01	.0000E+00	NO
51108086		-.1974E-01	.0000E+00	NO	51108090		-.2079E-01	.0000E+00	NO	51107061		-.2903E-01	.0000E+00	NO
51107013		-.4434E-01	.0000E+00	NO	51107067		-.5137E-01	.0000E+00	NO	51107051		-.5561E-01	.0000E+00	NO
51107050		-.5561E-01	.0000E+00	NO	51103089		-.5617E-01	.0000E+00	NO	51108096		-.5822E-01	.0000E+00	NO
51108088		-.6001E-01	.0000E+00	NO	51003005		-.6012E-01	.0000E+00	NO	51108009		-.6012E-01	.0000E+00	NO
51108082		-.7542E-01	.0000E+00	NO	51108071		-.7971E-01	.0000E+00	NO	51108057		-.9760E-01	.0000E+00	NO
51108008		-.1044E+00	.0000E+00	NO	51108007		-.1454E+00	.0000E+00	NO	51107081		-.1571E+00	.0000E+00	NO
51108011		-.1740E+00	.0000E+00	NO	51107002		-.1740E+00	.0000E+00	NO	51108001		-.1740E+00	.0000E+00	NO
51107010		-.1740E+00	.0000E+00	NO	51107089		-.1901E+00	.0000E+00	NO	51103092		-.1939E+00	.0000E+00	NO
51108065		-.1939E+00	.0000E+00	NO	51108005		-.1944E+00	.1900E+02	YES	51108076		-.1974E+00	.0000E+00	NO
51108077		-.2019E+00	.0000E+00	NO	51107074		-.2228E+00	.0000E+00	NO	51107076		-.2357E+00	.0000E+00	NO
51107088		-.2840E+00	.0000E+00	NO	51107062		-.2849E+00	.0000E+00	NO	51108084		-.2968E+00	.0000E+00	NO
51108073		-.3047E+00	.0000E+00	NO	51108072		-.3047E+00	.0000E+00	NO	51108069		-.5675E+00	.9000E+01	YES
51108070		-.6888E+00	.7000E+01	YES	51107066		-.1040E+01	.9000E+01	YES	51107007		-.1076E+01	.8300E+02	YES
51107063		-.1083E+01	.8000E+01	YES	51107001		-.1121E+01	.1200E+03	YES	51108095		-.1386E+01	.9000E+01	YES
51103068		-.1422E+01	.2400E+02	YES	51107082		-.1425E+01	.1600E+02	YES	51108097		-.1433E+01	.8000E+01	YES
51108074		-.1463E+01	.3200E+02	YES	51107075		-.1483E+01	.1700E+02	YES	51108054		-.1518E+01	.2300E+02	YES
51107058		-.1743E+01	.4300E+02	YES	51108093		-.1839E+01	.7000E+01	YES	51108006		-.1844E+01	.1300E+02	YES
51108060		-.1988E+01	.0000E+00	NO	51107054		-.2029E+01	.0000E+00	NO	51107012		-.2041E+01	.1200E+02	YES
51103091		-.2049E+01	.0000E+00	NO	51107011		-.2122E+01	.0000E+00	NO	51103090		-.2354E+01	.0000E+00	NO
51107006		-.2415E+01	.0000E+00	NO	51103020		-.2469E+01	.0000E+00	NO	51107060		-.2469E+01	.0000E+00	NO
51103002		-.2592E+01	.0000E+00	NO	51108058		-.2612E+01	.0000E+00	NO	51108055		-.2612E+01	.0000E+00	NO
51107072		-.2676E+01	.0000E+00	NO	51108064		-.2739E+01	.0000E+00	NO	51108053		-.2739E+01	.0000E+00	NO
51108066		-.2739E+01	.0000E+00	NO	51107064		-.2918E+01	.0000E+00	NO	51107090		-.3013E+01	.0000E+00	NO
51107077		-.3286E+01	.0000E+00	NO	51103015		-.3298E+01	.0000E+00	NO	51107003		-.3388E+01	.0000E+00	NO
51107084		-.4040E+01	.0000E+00	NO	51108051		-.4045E+01	.0000E+00	NO	51107083		-.4095E+01	.0000E+00	NO
51107056		-.4228E+01	.0000E+00	NO	51108059		-.4228E+01	.0000E+00	NO	51107068		-.4310E+01	.0000E+00	NO
51107071		-.4340E+01	.0000E+00	NO	51108081		-.4363E+01	.0000E+00	NO	51108080		-.4363E+01	.0000E+00	NO
51107079		-.4664E+01	.0000E+00	NO	51107069		-.4664E+01	.0000E+00	NO	51107070		-.4818E+01	.0000E+00	NO
51107085		-.5117E+01	.0000E+00	NO	51108063		-.5174E+01	.0000E+00	NO	51108067		-.5174E+01	.0000E+00	NO
51107055		-.5174E+01	.0000E+00	NO	51107073		-.5275E+01	.0000E+00	NO	51108079		-.6140E+01	.0000E+00	NO
51108075		-.6140E+01	.0000E+00	NO	51107086		-.6167E+01	.0000E+00	NO					

SELECTED RESOURCE= .9840000E+03 NON-SELECTED RESOURCE SUPPLY= .0000000E+00 TOTAL= .9840000E+03 PERCENT OF TARGET= 100.4

YEAR= 2060 MASTER CYCLE= 8 POLICY= 2 TARGETED RESOURCE=   .0000000E+00 MSPLABEL= TIMBER
NOTE: POLICY HIERARCHY IN USE. STANDS SELECTED UNDER POLICY 2 ARE LIMITED TO STANDS NOT SELECTED UNDER POLICY 1.
SELECTED RESOURCE= .0000000E+00 NON-SELECTED RESOURCE SUPPLY= .1448164E+06 TOTAL= .1448164E+06

Figure 12—The multistand treatment schedule report for master cycle 8, year 2060, generated when running the hierarchy example described in the first section of the text.

resource is credited toward the target for the second policy. When a hierarchy is not being simulated, nonselected resource is always credited toward the target. For example, if the target is an amount of timber, then removals from stands that are not selected for harvest, yet yield timber, is credited toward the target. Differences between the "TOTAL" and the "TARGETED RESOURCE" usually result from selecting entire stands. The difference is expressed as a "PERCENT OF TARGET." When the target resource is zero, the body of the table is not printed. This is the case for the report printed at the bottom of figure 12.

PPE Logical Flow

Schematic diagrams illustrating the logical flow of the Prognosis Model and the PPE are presented in figure 13. The Prognosis Model flow diagram is drawn to show the flow if the Prognosis Model is run for many stands. As you can see, the logical flow is to run each stand over all Prognosis Model cycles (labeled P-cycles in the figure) before simulating the development of the next stand. Simulation of pest dynamics in the Prognosis Model is illustrated to show the context of pest models with the Prognosis Model and to contrast how pest models are linked for serial single-stand simulations as opposed to parallel multistand simulations. The Event

```
         ┌─> For each stand

             Read Prognosis Model commands
             Read stand data and calibrate

         ┌─> For each P-cycle

             Call Event Monitor
             Simulate cuttings
             Call Event Monitor
             Predict increments

           ┌> For each year in P-cycle
           │  Simulate single-stand pest dynamics
           └  Next year in P-cycle

             Compute pest-caused damage
             Add increments
             Add regeneration

             Write reports

         └──── Next P-cycle
         └───── Next stand
```

```
             Read PPE commands

       ┌─> For each stand

           Read Prognosis Model commands
           Read stand data and calibrate
           Simulate to master starting year

       └─ Next stand

           Read PPE commands

   ┌───> For each master cycle

       * Process multistand treatment scheduling
```

Logic for normal master cycles	Logic for INTERACT cycles

`┌──> For each stand`
 	
`┌─> For each P-Cycle in a master cycle`
 	
`    Call Event Monitor`
`    Simulate Cuttings`
`    Call Event Monitor`
`    Predict increments`
 	
`  ┌> For each year in P-cycle`
`  │  Simulate single-stand pest dynamics`
`  └  Next year in P-cycle`
 	
`    Compute pest-caused dynamics`
`    Add increments`
`    Add regeneration`
 	
`└── Next P-cycle in master cycle`
`└─── Next stand`
	`┌─> For each stand`
	
	`    Call Event Monitor`
	`    Simulate cuttings`
	`    Call Event Monitor`
	`    Predict increments`
	
	`└ Next stand`
	
	`┌> For each year of master cycle`
	`* Simulate multistand pest dynamics`
	`└ Next year in master cycle`
	
	`┌> For each stand`
	
	`    Compute pest-caused damage`
	`    Add increments`
	`    Add regeneration`
	
	`└ Next stand`

```
   └──── Next master cycle

         Write reports
```

Figure 13—Simplified logical flow of the Prognosis Model (top) and the
PPE (bottom). All components of the Prognosis Model exist in the PPE.
Components of the PPE that operate at the multistand level are indicated
in bold type and marked with a *.

Monitor is an important component of the Prognosis Model and the PPE. It is called once at the beginning of each cycle and again after cuttings are simulated.

The logical flow of the PPE is shown at the bottom of figure 13. All components of the Prognosis Model logic can be identified within the PPE logical flow. Note the following features of the PPE's logical flow:

1. All of the stands are entered into the model and simulated up to the master starting year prior to entering the PPE master cycle loop. The process of simulating the growth up to the master starting year includes the complete Prognosis Model logic.

2. At the beginning of each master cycle, the PPE processes multistand treatment scheduling. Recall that the scheduling process can include creating stand replicates, effectively increasing the number of stands.

3. There are two kinds of master cycles, labeled normal and INTERACT in the figure. If the model is running a normal cycle, the logic in the left box is used, for INTERACT cycles the logic in the right box is used. In the discussion of Prognosis Model and PPE time increments (page 15 and fig. 8) it is pointed out that special logic is needed to simulate between-stand spatial interaction using annual (or smaller) time increments. There can only be one Prognosis Model cycle in an INTERACT master cycle. Therefore, no P-cycle loop is shown in the right box. More than one P-cycle can exist in a normal master cycle requiring that a P-cycle loop be included in the left box.

4. Calls to the Event Monitor can result in the creation of decision tree nodes and branches. This is permitted by the PPE in both normal and INTERACT cycles, but it is logically incompatible with the simulation of multistand pest dynamics. When replicates are created, the number of stands are increased, so the PPE must allow the upper limit of the "For each stand" loops to increase dynamically.

5. If a specific master cycle includes multistand pest dynamics, that master cycle must be an INTERACT cycle. However, you may specify a cycle to be an INTERACT cycle without running multistand pest dynamics. The PPE does not permit any stand replication process to occur in a model run that includes multistand pest dynamics. Future versions of the PPE may not have this restriction.

In summary, note that the PPE logical flow includes two components that operate at the multistand level; both are shown in bold in figure 13. The first is the multistand treatment scheduling logic. The spatial dimension of this component is all stands in the run and the temporal resolution is the master time interval. The other multistand component, multistand pest dynamics, has the same spatial dimension but allows for annual temporal resolution. In fact, the annual resolution could be changed to some other increment of time, either less than annual, such as a combination of seasonally and daily as done in the western budworms model (Sheehan and others 1989), or longer than annual.

New multistand components to the PPE can be added at either of these locations in the PPE's logical flow. The PPE offers some new flexibility to developers interested in simulating environmental system components at multistand spatial scope, short to long term temporal scope, and with varying temporal resolutions.

USING THE PPE

General Concepts   You control the PPE using a set of keyword records that are formatted the same way Prognosis Model (Wykoff and others 1982) keyword records are formatted. The keyword is coded in the first eight columns of the record; seven numeric data fields start in column 11; each field is 10 columns long. If you leave a field blank, the default value, if one exists, will be substituted by the program.

When the program starts, it is prepared to accept PPE keyword records you enter. The ADDSTAND keyword causes the program to call the base Prognosis Model so that the keyword records it recognizes can be entered. For a specific stand, the inventory year, stand specific data, thinning options, and so on, are entered using exactly the same techniques used when the Prognosis Model is used without the PPE.

When the Prognosis Model PROCESS keyword is reached, the stand is projected up to the master starting year, and the data that represent the stand are stored. The options table, calibration statistics, and a summary table are printed before any more PPE keywords are read.

When all of the stands are entered using ADDSTAND keywords, a PROJECT keyword is entered to invoke the projection phase of the PPE's operation. At the end of the projection, the yield tables are printed by entering a YIELDS keyword, and the detailed stand tables are printed by entering a STNDTABS keyword.

The operation of the PPE may be limited to just the ADDSTAND, PROJECT, YIELDS, and STNDTABS keyword records plus the necessary Prognosis Model keywords used to enter the stand and tree data. However, in most cases, several additional keywords are used to take advantage of the PPE's power.

There are five major categories of keyword records: (1) cycle control keywords control the number, length, and processing mode of master cycles; (2) program control keywords are used to add stands, schedule program execution pauses, stop the program, and so on; (3) output control keywords are used to generate reports; (4) multistand treatment scheduling keywords control multistand targets and priorities; and (5) keywords used in the PPE and Prognosis Model system for adding comments, stopping the program, and file-handling.

The final topic of this section is related to templates. When using the PPE, the options specified for a stand can be considered a template for subsequent stands. That is, all of the options for a specific stand can become a default set of options for subsequent stands. This topic is explained in detail below.

Cycle Control—The master starting year of a PPE projection is entered using the STARTYR keyword, the number of master cycles is entered using the MSTRCYCS keyword, and the length of the master cycles is controlled using the MSTRINT keyword. If any of these three keywords are not entered before the first ADDSTAND keyword, the corresponding values entered in the base Prognosis Model for the first stand are used instead. TIMEINT is the Prognosis Model keyword that corresponds to the PPE's MSTRINT keyword, NUMCYCLE corresponds to MSTRCYCS, and INVYEAR corresponds to STARTYR. Once the first stand is entered, the master starting year and the number and length of the master cycles are defined. It is illegal to redefine them.

When within-cycle stand interactions are simulated, the PPE uses special processing logic. This logic provides Prognosis Model extensions with necessary additional control over the manipulation of internal data. However, it requires that all stands in the run can cycle only once during these interaction master cycles. If you specify extra Prognosis Model cycles during a PPE interaction cycle, the PPE will automatically delete them.

The INTERACT keyword can be used to specify which cycles and stands are processed using the within-cycle interaction logic. Note that the Prognosis Model extensions that need interaction cycles automatically invoke the INTERACT option. Unless the option is invoked, all cycles and stands are simulated using noninteract cycles.

STARTYR   field 1: The starting year of the PPE projection; default is 0.

MSTRINT   field 1: The master cycle number that the time interval will be changed; default is all cycles.

                field 2: The time interval; default is 10 years.

MSTRCYCS   field 1: The number of master cycles; default is 1.

INTERACT   field 1: The master cycle number that will be processed using the within-cycle stand interaction logic. If blank, the keyword affects all cycles. All of the stands that follow this keyword are affected by it.

Program Execution—As noted above, the ADDSTAND keyword signals that Prognosis Model keywords follow and the PROJECT keyword signals that all of the stands and PPE options have been entered so the projection may begin. (The PROJECT keyword also has another meaning; see the RESTORE keyword below.)

The PAUSE keyword is used to schedule a pause in PPE execution at the end of a specified master cycle (by entering a master cycle number in field 1), or immediately after the keyword is recognized by the PPE (by leaving field 1 blank). When, during the run, a scheduled pause is executed, the PPE stores its memory and then processes more keyword records. When an immediate PAUSE is executed (that is, it is not scheduled to occur at the end of a specified master cycle), the PPE stores its memory and stops execution.

The RESTORE keyword is used to recover PPE memory after a pause has occurred. When the PROJECT keyword follows a RESTORE, the PROJECT keyword signals that the projection should continue. PPEINIT reinitializes the PPE. Three more keywords in this group, DEBUG, NODEBUG, and READHIST, are described in appendix E.

ADDSTAND   Signal the PPE that the subsequent keywords are Prognosis Model keywords. Note that an ADDSTAND keyword may not occur after a PROJECT keyword unless PPEINIT (described below) is entered.

PROJECT   Signal the PPE that all of the individual stands have been entered and that the projection should start. If a scheduled PAUSE has been executed in a previous run, the PROJECT keyword is used to resume a projection.

PAUSE   field 1: The master cycle number in which the projection will end in a pause condition. If blank, a pause will occur as soon as the keyword is entered.

RESTORE   Restore the PPE's memory after a pause has been executed.

PPEINIT   Reinitialize the PPE. Placed between separate projections, this keyword allows several runs to be processed during one job step.

Example 1, Step 1: General Concepts—Two stands are run for the 50 years between 1990 and 2030 (fig. 14). The first stand, identified as STAND1, was inventoried in 1978, and the second stand, STAND2, was inventoried in 1984. For simplicity, default Prognosis Model options are used whenever possible. After the projection the PPE is paused. Output is generated in a subsequent job step and is described after the output keywords are described (see Example 1, Steps 2 and 3: Output Processing, p. 39). See appendix A for a listing of the input tree data and output generated by running this example.

Other Prognosis Model keywords, such as STDINFO and DESIGN, may be used to describe the stand more completely. Note that the Prognosis Model keywords NUMCYCLE and TIMEINT were not used to specify cycles. The PPE automatically schedules as nearly to 10-year cycles as possible for

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Example 1, Step 1

Reference line	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
1	STARTYR	1990.						
2	MSTRINT	1.	20.					
3	MSTRINT	2.	30.					
4	MSTRCYCS	2.						
5	ADDSTAND							
6	STDIDENT							
7	STAND1							
8	INVYEAR	1978.						
9	TREEDATA							
10	PROCESS							
11	ADDSTAND							
12	STDIDENT							
13	STAND2							
14	INVYEAR	1984.						
15	TREEDATA							
16	PROCESS							
17	PROJECT							
18	PAUSE							

Line 1: Enter the starting year for the PPE (1990).

Lines 2 to 4: Enter the number and length of the master cycles. Cycle 1 is 20 years long (from 1990 to 2010) and cycle 2 is 30 (2010 to 2040). Note that, by default, the Prognosis Model cycles will be 10 years long except for the cycles needed to simulate each stand from its inventory year to the master starting year.

Line 5: Signal that the first stand follows.

Lines 6 to 10: Prognosis Model keywords are used to define and enter the first stand.

Lines 11 to 16: The second stand is entered using the PPE keyword ADDSTAND, followed by Prognosis Model keywords.

Line 17: Projection occurs when PROJECT keyword is found.

Line 18: Pause the PPE run.

Figure 14—Keyword records for Example 1, Step 1, illustrating general concepts of the PPE's operation.

each stand under the restrictions that (1) all stands must have a cycle that corresponds to master cycles, and (2) if the INTERACT option is used during one or more master cycles, all stands must cycle identically to the PPE and to each other during those specific master cycles.

Output Processing

Output reports written by the PPE are controlled by two sets of keywords. The first set described in this section consists of keywords that control which *stands* are included in the reports. The "SEL..." keywords are used to select a list of stands for processing, and the "BY..." keywords are used to group the selected stands into subgroups. The "BY..." keywords are useful only for controlling which stands are grouped together in composite yield tables.

The second set controls which *reports* are written for selected stands. The STNDTABS keyword is used in conjunction with several other keywords (described below) to request that the detailed stand tables be printed. The YIELDS keyword is used to request summary and composite yield tables be processed. Some additional output, as described below, is also processed when the YIELDS keyword is used. When the Cover Model (Moeur 1985) is used, the CVOUTPUT keyword is used to generate output reports.

Selecting Stands for Output—SELISN, SELSTAND, SELMGMID, SELSPLAB, SELMSPLB and NOSELECT keywords are used to select which stands will be included when generating individual and composite yield tables using the YIELDS keyword, detailed stand tables using the STNDTABS keyword, and cover output using the CVOUTPUT keyword. A given stand must match the condition stated in the "SEL..." conditions to be selected for processing. If more than one of these options is used at once, each stand must meet all of the criteria to be included in the output. For example, a SELSPLAB option could limit the output to stands that are labeled with a given stand policy label, and a SELMGMID option could limit output to stands with a given management identification. The output will include stands that are labeled with specified policy label *and* the specified management identification.

SELISN Enter the ISN of stands to be processed when YIELDS or STNDTABS or both are requested.

Supplemental data record:

cols 1-20: Enter the internal stand number for the stand that will be selected. If blank, select all stands. If cols 21-40 are entered, col 1-20 specifies the lower end of a range of internal stand numbers.

cols 21-40: Enter the internal stand number for the upper end of the range of stands to be selected.

SELSTAND Enter the stand identification code for stands that are processed by YIELDS or STNDTABS or both.

Supplemental data record:

cols 1-8: The stand identification code for the stand that will be selected. If blank, select all stands. If cols 11-18 are entered, cols 1-10 specify the lower end of an alphanumeric

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		range of stand identification codes that will be selected.
	cols 11-18:	The alphanumerically largest stand identification code for the stand(s) that will be selected.

SELMGMID Enter the management identification code for stands that are processed by YIELDS or STNDTABS or both.

Supplemental data record:

	cols 1-4:	The management identification code for the stand that will be selected. If blank, select all stands. If cols 11-14 are entered, cols 1-4 specify the lower end of an alphanumeric range of stand identification codes that will be selected.
	cols 11-14:	The alphanumerically largest management identification code for the stand(s) that will be selected.

SELSPLAB Enter the stand policy label set for stands to be processed by YIELDS or STNDTABS or both. A stand is selected for output if its stand policy label set contains one member label that is also a member of the set specified using this option.

Supplemental data record(s):

Enter a list of stand policy labels, separated by commas as done for the SPLABEL and AGPLABEL keywords, that will be selected; if blank, select all stands. Continuation records follow records that contain an ampersand (&). The total number of characters in all policy labels, including the separating commas, cannot exceed 100.

SELMSPLB Enter the multistand treatment policy label for stands to be processed by YIELDS or STNDTABS or both. A stand is selected for output if it applies to the multistand treatment policy specified using this option.

Supplemental data record:

Enter a policy label; if blank, select all stands. Continuation records are not allowed; the length of a multistand policy label cannot exceed 40 characters.

NOSELECT Turn off the effect of all other "SEL..." options.

Grouping Stands for Composite Yield Tables—Selected stands may be grouped for processing by the YIELDS keyword using "BY..." keywords. The BYSTAND option creates subgroups of the stands that have the same stand identification (handy when a single stand has branched creating replicate stands that have the same identification). The BYMGMID option makes subgroups out of the stands that carry the same management identification. BYSPLAB and BYMSPLB key on policy labels; a subgroup is created for each unique policy, and all of the stands that pertain to the policy are processed as individual subgroups.

A NOBYGRP keyword is used to turn off the effect of previously specified "BY..." keywords. BYSTAND, BYMGMID, BYSPLAB, and BYMSPLB are

mutually exclusive options. If more than one is specified, the last one entered takes precedence.

BYSTAND   All of the stands that have the same stand identification will be grouped. A composite yield table is generated for each unique stand identification.

BYMGMID   All of the stands that have the same management identification will be grouped. A composite yield table is generated for each management identification.

BYSPLAB   A list of unique stand policy labels is created by the PPE (by taking a union over all stand policy label sets). Subgroups are formed for each unique label by creating lists of stands that contain the unique label in the stand policy label set. A composite yield table is generated for each stand policy. Note that using this option can result in one stand being counted in more than one composite yield table.

BYMSPLB   Subgroups of stands are formed for each multistand treatment policy; a composite yield table is generated for each.

NOBYGRP   Turn off the effect of previously specified "BY..." keywords.

Generating Detailed Stand Table Output—The STNDTABS keyword is used in conjunction with the following keywords to control printing detailed stand tables.

STNDTABS   Signal that printing of stand tables is to occur. Unless SNDCMP, NOSNDCMP, SMPTRE, and NOSMPTRE (see below) keywords are used to change default conditions, the stand composition table and the sample tree and stand attribute table are printed when this keyword is entered.

SNDCMP
NOSNDCMP   Request stand composition tables be printed (SNDCMP) or suppressed (NOSNDCMP) when STNDTABS is entered; default is SNDCMP.

SMPTRE
NOSMPTRE   Request the sample tree and stand attribute tables be printed (SMPTRE) or suppressed (NOSMPTRE) when STNDTABS is entered; default is SMPTRE.

Generating Yield Tables—The YIELDS keyword triggers creation of composite yield tables and the writing of several other output statistics. Several keywords in this group are used to control which statistics are created and output when the YIELDS keyword is entered. The composite yield table may or may not be created, and it may be output with or without headings to any data set. Output of individual stand summary tables can be similarly controlled.

The NEWEIGHT keyword is used to change the branch weight of a stand. If NEWEIGHT is specified before a composite yield table is created, the new branch weight is used in computing the weights applied to individual summary tables when they are averaged.

AUTOID is used to request the PPE to automatically create management identifications for each summary statistic or composite yield table produced. You may specify the first few characters of the automatically generated

management identifications and the starting sequence number. COMPID is used to enter a management identification for composite yield tables.

Additional keywords control the creation of a machine-readable file containing the PPE stand weighting factors for each stand, the list of activities that were accomplished during the simulation of growth for each stand, the stand policy labels, and the harvest policy labels for each stand (see appendix B for a description of this output).

YIELDS   Signal that processing of yield data (composite and summary tables) is to occur. Unless other keywords are used to change default options, the YIELD processing consists of printing the summary statistics and activity summary tables for each stand, and, after computing a weighted average yield table from all stands, a composite yield table is printed. The weight for each stand used in computing the average is the PPE stand weighting factor described in the section "Composite Yield Statistics," page 13. This factor is the product of the stand size or sampling weight and the branch weight.

COMPOSIT
NOCOMPOS   Control the creation and printing of a composite yield table when YIELDS is entered; COMPOSIT is the default.

COPYCOMP
NOCOPCMP   Control the creation and writing of a machine-readable copy of the composite yield table when YIELDS is entered; NOCOPCMP is the default.

field 1: Data set reference number; default is 4.

SUMMARY
NOSUM   Control the printing of the individual summary tables when YIELDS is entered; SUMMARY is the default condition.

COPYSUM
NOCOPSUM   Control the writing of the individual summary tables when YIELDS is entered; NOCOPSUM is the default.

field 1: Data set reference number; default is 4.

ACTSUM
NOACTSUM   Control the printing of the individual activity summaries when YIELDS is entered; default is ACTSUM.

NEWEIGHT   Enter a new branch weighting factor for a given stand. The weighting factor is used in computing all subsequent composite yield tables.

Supplemental data record:

cols 1-20:   The ISN for the stand with the new weight.

cols 21-30: The new branch weighting factor.

AUTOID
NOAUTOID   Request the PPE to generate unique management identification codes for summary tables and the composite yield tables. NOAUTOID turns the option off and is the default.

field 1: The starting sequence number for the identifications; zero is the default. If you enter a negative number, the starting identification is entered on a supplemental data record, and it may include alpha codes.

Supplemental data record:

cols 1-4: The template for identification codes. The template may be up to four characters long. If the last one, two, three, or four characters are a number, then that number is the starting sequence number. Examples: For a template ABC9, the first four identifications are ABC9, AB10, AB11, and AB12. For a template of HARV, the first four are HARV, HAR0, HAR1, and HAR2.

COMPID   Enter a management identification for the composite yield tables.

Supplemental data record:

cols 1-4: The composite yield table management identification.

LABWTS
NOLABWTS   Request that the label and weights file be written when YIELDS is entered; NOLABWTS is the default.

field 1: Data set reference number on the LABWTS keyword; there is no default.

LABWTSID   Enter a four-character identification for the label and weights records created when the LABWTS keyword is used.

Supplemental data record:

cols 1-4: The label and weights identification; default is " LBW".

Generating Cover Model Output—You must follow the instructions found in Moeur (1985) for entering Cover Model options necessary to generate canopy and shrub statistics. The Cover Model keywords are entered for each stand along with Prognosis Model keywords. However, when the Cover Model is used in conjunction with the PPE, no output is written nor printed until the CVOUTPUT keyword is entered.

CVOUTPUT   Generate reports computed by the Cover Model for stands that are selected using the "SEL..." options.

field 1: If any number greater than zero is entered, canopy cover statistics (see fig. 2 of Moeur 1985) are printed.

field 2: If any number greater than zero is entered, shrubs statistics (see fig. 4 of Moeur 1985) are printed.

field 3: If any number greater than zero is entered, the canopy and shrubs summary (see fig. 2 of Moeur 1985) is printed.

field 4: If any number greater than zero is entered, a selected set of canopy and shrub statistics is written to a data set referred to in field 5 without headings. The data elements in this file and the file format are described in appendix B.

field 5: Data set reference number for cover data written without headings; default is 24.

Example 1, Steps 2 and 3: Output Processing—Example 1 is continued to illustrate how to generate output reports. The keywords illustrated at the top of figure 15 will restore the PPE and generate a composite yield table for STAND1 and STAND2.

After reviewing the composite yield table, you may wish to examine the stand composition table from STAND2 and the summary statistic tables for both stands. Use the keyword file for step 3 illustrated in figure 15.

Output for this example is in appendix A.

Miscellaneous Keywords

Prognosis Model and PPE Keywords—A few keywords are recognized by the Prognosis Model and the PPE. You may enter them before or after ADDSTAND keywords. They are used to enter comments and for file handling. The files the PPE and Prognosis Model need for normal operation are opened and closed by the program automatically. The file-handling keywords are useful for assigning input files, for example tree data files, and output files such as summary data files. WARNING: It is possible to destroy files critical to the PPE using the file-handling keywords.

COMMENT — Records that follow this keyword contain comments. A record that contains 'END' in the first three columns signals the end of the comment records.

STOP — Stop the program.

ADDFILE — The file referenced by the data set reference number specified in field 1 contains keyword records that are read when this keyword is specified. The file is read until an end-of-file mark is detected.

field 1: Data set reference number for the keyword file to add. If blank, the current keyword file is read.

REWIND — field 1: Data set reference number to rewind; no default, an entry is required.

ENDFILE — field 1: Data set reference number to write an end-of-file; no default, an entry is required.

OPEN — A FORTRAN file OPEN is requested using this keyword. The file name is entered on a supplemental record. Note that not all FORTRAN file attributes are supported by the PPE; some are valid for one operating system and not for another. Regardless of the operating system, the file must be a formatted, sequential file.

On Data General computers (under AOS/VS), the file will be "data sensitive" and "padded" with blanks to a record length of 80 characters unless you specify a different length in field 4 of the keyword record.

Line 1: Restore PPE memory.

Lines 2 and 3: Request that the printed yield tables not include the Summary Statistics nor Activity Statistics tables.

Line 4: Create and print the Composite Yield table.

Line 5: Stop the run.

Line 1: Restore PPE memory.

Lines 2 and 3: Use the SELSTAND option to specify that only STAND2 should be selected for output.

Line 4: Turn off the Sample Tree table output.

Line 5: Use the STNDTABS keyword to generate the Stand Composition table.

Line 6: Turn off the effect of lines 2 and 3.

Line 7: Request that Composite Yield table be printed.

Line 8: Turn off the Summary Statistics table.

Line 9: Generate the yields output.

Line 10: Stop the PPE.

Figure 15—Keyword records for Example 1, Step 2, illustrating how to generate a composite yield table, and for Example 1, Step 3, illustrating how to generate stand composition and activity summary tables.

field 1: Data set reference number (or UNIT) to open; no default.

field 2: Enter a nonzero value if blanks in the data set are to be treated as NULL characters. Enter a blank field or a zero (which is the default) to signify that blanks be treated as zeros when the file is read for numeric data.

field 3: Enter a code for the file status: 0 (or leave the field blank) for UNKNOWN, 1 for NEW, 2 for OLD, and 3 for FRESH or REPLACE (not supported on all machines).

field 4: The MAXRECL parameter for Data General computers or the MRECL parameter on Unisys computers; default is 80 characters.

Supplemental data record:

cols 1-80: Enter the data set name with no leading blanks.

CLOSE   field 1: Data set reference number to close.

Stand Option Templates—Frequently, the same options are applicable to several stands. Using the template feature of the PPE, you only need to enter options that apply to a group of stands once. All of the stands that follow will inherit the options.

The template feature works like this: You enter the TEMPLATE keyword before an ADDSTAND. The options entered for stands that follow the TEMPLATE keyword are inherited by subsequent stands. If you enter more options in a subsequent stand all of the options entered for the first stand plus all those entered for the second are inherited by the third.

Not all Prognosis Model options are inherited. Inherited options are: All activity keywords (those that are scheduled with a date or cycle in the first field), all logical expressions, and all COMPUTE options. Options that are not inherited include the stand site variables, tree data, and calibration terms.

TEMPLATE   Signal options entered for the next stand are inherited by subsequent stands.

TMPLINIT   Signal that the template be suspended.

Using the Event Monitor With the PPE

The Event Monitor (Crookston 1990) is a critically important element of the Prognosis Model and the PPE. You should consider the Event Monitor user's guide an integral part of this document, particularly the "Advanced Features" of the Event Monitor (pp. 5-10, Crookston 1990). In this section, four topics are covered. The first is a review of the THEN and ALSOTRY keywords to document the parameter fields on these keywords. When used with the Prognosis Model the parameter fields have no meaning, but when used with the PPE, they have specific utility. The second covers guidelines for coding policy labels. The third and fourth sections provide two examples of using the Event Monitor with the PPE.

Modifying Branch Weighting Factors—The THEN keyword signals that activities that follow should be scheduled only when a preceding logical expression is true (see p. 3, Crookston 1990). The ALSOTRY keyword signals that an alternative group of activities be tried (see p. 9, Crookston 1990). The PPE can create a replicate of the stand and schedule the group of activities that follow the THEN keyword for one replicate and schedule the group that follows the ALSOTRY to the other group. This is how decision trees are generated in the PPE, as explained on pages 8 and 19 of this guide. When branches of the resulting decision tree must be assigned different branch weighting factors, appropriate multipliers must be coded

on the THEN and ALSOTRY keywords. These multipliers are coded in the first field of the keywords. Note that the PARMS feature (p. 6, Crookston 1990) can be used to code expressions of stand state variables in place of entering constants in the first field of these keywords. This use will be illustrated in "Example 3: Expected Value With Fires," page 44.

THEN   Signals that activities that follow will be scheduled following an event.

field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0.

ALSOTRY   Signals that an alternative group of activities follow that will be scheduled following an event.

field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0.

All of the other Event Monitor features are fully documented in Crookston (1990). The remainder of this guide assumes you have this supporting documentation.

Guidelines for Using Policy Labels—Drastically different results can be generated depending on how you code policy labels. The logic followed by the PPE during the simulation is outlined in "Rules for Processing Labels," page 21. Here are some guidelines for coding policy labels:

1. A logical expression and each activity group forms a policy. Use the AGPLABEL keyword to enter the name of the policy. If the logical expression and activity group apply to more than one policy, enter all of the names using the AGPLABEL keyword. For example, say a thinning policy (made up by a logical expression followed by appropriate thinning keywords) applies to intensive and extensive management. Then the AGPLABEL would be followed by *intensive, extensive*.

2. Use the SPLABEL keyword to list the policy names under which the stand should be managed. For example, if one stand should be managed under intensive management, the SPLABEL keyword is followed with *intensive*; if for another stand extensive management is appropriate, then use the SPLABEL keyword to label that stand for *extensive* management. If both policies are appropriate, label the stand *intensive, extensive*.

Important ramifications of the rules for processing labels are:

* If all activity group policy label sets do not contain any common members, and if the stand label set contains only one policy label, no branches will occur. Therefore, these cases may be processed equally well with either the Prognosis Model or the PPE.

* If two or more activity groups follow one IF keyword, and the activity group policy label sets do not contain any members in common, at most one branch will occur regardless of how many times the logical expression is true.

* If two or more activity groups follow one IF keyword, and the activity group policy label sets are overlapping, branching may occur each time the logical expression is true. The word *may* is used because in some cases branches are blocked from being formed by other program components.

Example 2: Prescription Selection by Name—Event Monitor Example 4 (p. 9, Crookston 1990), is presented within the context of the PPE. As presented in the Event Monitor user's guide, two stand management policies, one called *intensive* and the other *extensive*, are set up to run in the Prognosis Model as two separate executions of the model. Here the necessary modifications to the keyword file are presented so that both policies may be run simultaneously.

1. Insert ADDSTAND before line 1.
2. Change the stand policy label so that line 20 reads *intensive, extensive*.
3. Insert PROJECT after line 21, to cause the PPE to project the run.
4. After the PROJECT, add BYSPLAB to signal the PPE to group output by stand policy label, then add YIELDS to signal the PPE to process the yield tables.

The completed keyword file is illustrated in figure 16. Two output tables are generated; the first corresponds to *extensive* management and the other to *intensive*. The decision tree generated by running this example is like the one illustrated in figure 4 for contrasted policies.

Example 2

Reference line	Keyword	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
0.1	ADDSTAND							
1	STANDID							
2	EXAMPLE2	Prescription Selection by Name						
3	INVYEAR	1990.						
4	NUMCYCLE	10.						
5	IF							
6	BCCF GT 150 AND BTPA GT 500 AND AGE &							
7	GT 20 AND AGE LT 60							
8	THEN							
9	THINBTA	0.	300.					
10	FERTILIZ	1.						
11	AGPLABEL							
12	intensive							
13	ALSOTRY							
14	THINBTA	0.	300.					
15	AGPLABEL							
16	extensive							
17	ENDIF							
18	STDINFO	118.	710.	30.	135.	50.	56.	
19	SPLABEL							
20	intensive, extensive							
21	PROCESS							
21.1	PROJECT							
21.2	BYSPLAB							
21.3	YIELDS							
22	STOP							

Line 0.1: Add one stand to the PPE.

Lines 1 to 21: Exactly like Example 4, page 9 of Crookston (1990), except that line 20 contains both intensive and extensive.

Line 21.1 to 21.3: Signal the PPE to project the run and write yield tables.

Line 22: Stop the run.

Figure 16—Keyword records for Example 2, illustrating how to run two contrasted policies, *intensive* and *extensive*, using the PPE. This example is a modification of Example 4, page 9 of Crookston (1990).

Example 3: Expected Value With Fire—To illustrate many of the concepts of decision trees and Event Monitor use within the PPE, an example that includes contrasted policies and expected values, together in the same run, is presented. A similar example was described by Crookston and Stage (1989) at a conference on artificial intelligence and growth models. The run starts with bare ground. The goal is to calculate the expected total timber production given that stands are exposed to the risk of catastrophic fires. The expected production is computed for each of two stand management policies:

1. *Timber*: Manage the stand for timber output, regenerate when culmination of mean annual increment is reached via clearcutting; prepare the site, and plant.

2. *Scenic*: Manage the stand for scenic beauty, regenerate when the stand has reached culmination of mean annual increment only if stand density is low. Regenerate via shelterwood without overstory removal.

Catastrophic fires are considered random-occurring events. To run this example, two submodels are needed: (1) an equation that predicts the probability of a catastrophic fire and (2) a fire-caused tree mortality model. Unfortunately, neither of these submodels is available in the Prognosis Model system, so simple ones were improvised. The improvised models assume that both the probability of fire and fire-caused tree mortality are related to tree size and stand timber volume. The effects of fire suppression activities are accounted for in the calculation of event probability.

The keyword file needed to run this example is illustrated in figure 17. Explanations of the commands are included in the keyword file as comments. This example and the keyword file used to run it are more complicated than this description so far indicates. The Event Monitor rules used to implement the management policies had to be carefully crafted for stands that could burn at any time in their histories. Tricks were used to achieve the desired results. For example, the first logical expression includes the following: DECADE(0,MORT)*(YEAR–CENDYEAR+1). This expression is used to compute mortality per cycle for each cycle. The reason the DECADE function is used is that MORT is not defined until after the first cycle. If the expression had lacked the DECADE function, the logical expression would be false during the first cycle because the Event Monitor sets all expressions that are functions of undefined variables false. The second part of the expression, YEAR–CENDYEAR+1 computes the cycle length. MORT is measured in cubic feet per acre per year; multiplying by the cycle length converts MORT to a per-cycle basis.

Another trick was to create three branches whenever a decision tree node was created that represents the fire and no-fire cases. Two of the branches representing the no-fire case are weighted by half the complement of the probability of fire. This technique created extra replicates for a Monte Carlo approach, which was used when the decision tree approach was not used. To force each of these two replicates to be unique *samples*, another trick was employed. By adding ", RANN" to the second ALSOTRY, the program was told to draw a random number in the process of evaluating the expressions within PARMS. Only the first parameter is used by the ALSOTRY keyword, but both are evaluated. This trick forced the second no-fire replicate to have a unique random number sequence. Without this trick, the two replicates would have been identical.

```
COMMENT
* Set the number of cycles to 11, but let the last
* cycle be 200 years long.  Thus, the projection
* will be 300 years.  This can be done because all
* of the branching will take place within the first
* 10 cycles.
END

MSTRCYCS     11.
MSTRINT      11.        200.

ADDSTAND
STDIDENT
Example3        Expected Value with Fire
NOTREES
INVYEAR        1990.

* ESTABLISHMENT: When mortality exceeds 50 % of
* standing volume OR when stand density is very
* low, then set up plantings.

IF
(DECADE(0,MORT)*(YEAR-CENDYEAR+1) GT ATCUFT*.5) OR &
(ATPA LT 50)
THEN
ESTAB
RESETAGE     0.         0.
PLANT        1.         3.        200.
PLANT        1.        10.        200.
END
AGPLABEL
   timber, scenic
ENDIF

* HARVEST CUTS:
* Policy=timber: Clearcut any time culmination of
* m.a.i. occurs.
* Policy=scenic: Shelterwood if culmination of
* m.a.i. occurs and trees per acre falls below 100.
* These cases are coded as two mutually exclusive
* rules--only one of the rules can be true at
* any one time.

IF
PAI LT MAI AND BTPA LT 100
THEN
THINDBH      0.         0.                   1.
AGPLABEL
   timber
ALSOTRY
THINBTA      0.        40.         .8
AGPLABEL
   scenic
ENDIF
IF
PAI LT MAI AND BTPA GE 100
THEN
THINDBH      0.         0.                   1.
AGPLABEL
   timber        .
ALSOTRY
AGPLABEL
   scenic
ENDIF
```

```
* Compute probability of fire as a function of
* post-thin ccf.  The fire mortality rates depend
* on tree diameters.

COMPUTE      0.
FIREPROB = LININT(ACCF,0,20,100,0,.01,.02)
END

* Two approaches are used to represent the fire
* events.  The first uses a decision tree whereby
* each branch is weighted by its associated
* probability of occurence.  The second is a
* Monte Carlo process whereby the probability of a
* fire is compared to a random number, and the
* fire event is simulated if the random number is
* less than the probability.  The Monte Carlo
* approach will work fine if there are enough stand
* replicates.

* If the current branch weighting factor is
* over 0.0005 and the probability of fire is
* over 0.005  and there is an available decision
* tree node, then create a node and three branches.
* The branch weighting factor of the first branch
* is multiplied by the probability of fire and the
* other branch weighting factors are multiplied by
* the complement times .5.  This technique creates
* plenty of replicates for the stochastic approach.

IF           0.
BRCHWT GT .0005 AND FIREPROB GT 0.005 AND NODES LT 5
THEN         PARMS(FIREPROB)

* Use FIXMORT to kill trees, thereby simulating fire.

FIXMORT      0.         0.        1.0        0.        .99
FIXMORT      0.         0.        0.9        1.0       2.99
FIXMORT      0.         0.        0.8        3.0       7.99
FIXMORT      0.         0.        0.7        8.0       999.
ALSOTRY      PARMS((1-FIREPROB)*.5)

* Force the replicate to have a unique random sequence
* by drawing a random number.

ALSOTRY      PARMS((1-FIREPROB)*.5,RANN)
ENDIF

* If the decision tree approach is not being used
* then, switch to the stochastic approach.

IF           0.
   NOT (BRCHWT GT .0005 AND FIREPROB GT 0.005 AND &
   NODES LT 5) AND RANN LT FIREPROB
THEN
FIXMORT    , 0.         0.        1.0        0.        .99
FIXMORT      0.         0.        0.9        1.0       2.99
FIXMORT      0.         0.        0.8        3.0       7.99
FIXMORT      0.         0.        0.7        8.0       999.
ENDIF

PROCESS
PROJECT
BYSPLAB
COPYCOMP
YIELDS
STOP
```

Figure 17—Keyword records for Example 3, illustrating many concepts of using the Event Monitor and the PPE to represent stochastic processes and contrasted management policies.

Such careful craftsmanship of keyword files is, unfortunately, necessary when solving some problems. An easier approach would be to create two separate problems, one for each policy, and then introduce the fire process. This approach is almost required if you wanted to include intermediate treatment rules for the *timber* policy, and different ones for the *scenic* policy.

Still, it would be difficult to run this problem without the PPE. The program created about 100 replicates for each policy and automatically computed the expected yields. Now that the approach has been established, modifications, such as inserting different fire components, are easily made, making it a simple task to evaluate a fire suppression policy.

Figure 18 contains a graph of the total production (standing volume plus accumulated removals) over time for each policy, run once with the fire components and once without (the keyword file for the without-fire case is not illustrated). The outcome of this run demonstrates that management for scenic quality reduces timber production, an expected result. It also illustrates that expected losses to fire are not notably different between the two policies. If fire had not been a factor, total production would have been 7 percent higher for the scenic and 5 percent higher for the timber policy. Crookston and Stage (1989) showed that exposing high volumes to risk over long periods more dramatically increased expected losses. One reason for the different results is that different habitat types were used, and higher volumes were at risk in *scenic* option.

In summary, this example illustrates that both stochastic and contrasted policy decision trees may be represented by the PPE within the same run. It illustrates the use of the PARMS feature of the Event Monitor and how to modify the branch weighting factors as a function of dynamically changing stand conditions. It shows how a Monte Carlo simulation can be combined with decision trees. Finally, it demonstrates that simply stated problems are not always easy to solve.

Controlling Multistand Treatment Scheduling

Keywords—The MSPOLICY keyword is used to define the four elements of a multistand policy: (1) the formula used to define the target, (2) the formula used to assign selection priorities to stands, (3) the formula used to compute the contribution each stand makes toward the target, and (4) a name for the policy. You may code up to 15 different harvest policies. The MSPOLICY keyword is also used to control output generation, to enter the initial value of OLDTARG (a variable you can use in the TARGET expression), and to signify that a hierarchy is being specified.
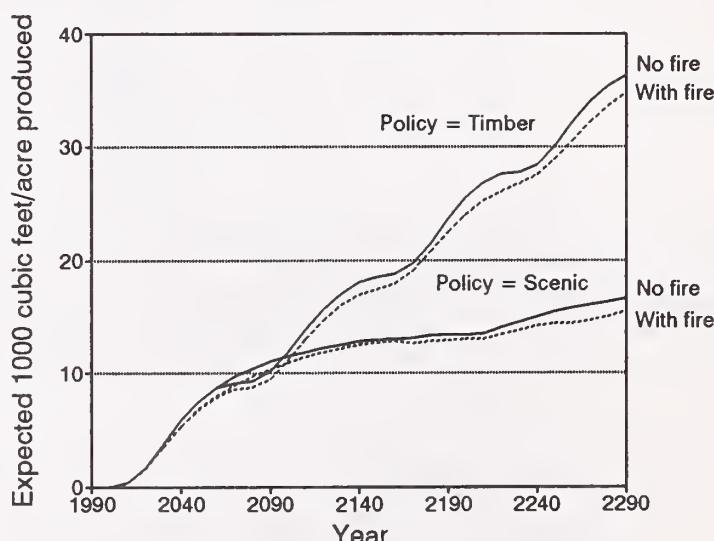
Figure 18—Expected total production (standing volume plus cumulated harvested volume) for the *timber* and *scenic* policies given the risk of catastrophic fires is present (With fire), and not present (No fire).

Following the MSPOLICY keyword, you define the TARGET, PRIORITY, CREDIT, and MSPLABEL by coding expressions on supplemental data records. An END keyword is entered to signal that the policy has been defined. The rules for coding the expressions are similar to the rules for coding the COMPUTE option except that the left side of the equal sign is one of the four predefined names listed above. In addition, the variables you can use on the right side of the equal sign are from a special group. The rules are described in detail below.

The EXACT and NOTEXACT keywords control what happens when the selection logic determines that only a portion of a stand's resource is needed to satisfy a target. If the EXACT keyword is specified, the PPE will replicate the stand, *select* one replicate, and *not select* the other. The PPE modifies the branch weighting factor for each replicate using the proportion of the stand needed to meet the target. When the NOTEXACT option is specified, the PPE does not replicate the stand. Then, if over half the stand is needed, it is selected, and if under half is needed, it is not. The target is not exactly met when NOTEXACT is used. The PPE automatically invokes the NOTEXACT option if it cannot find enough room to store a replicate when one is needed.

The maximum clearcut size is entered using the MXCLRCUT keyword. The definition of a clearcut, defined using the DEFCCUT keyword, is a stand where the top height is less than a height you enter *and* where there are fewer than a number of trees per acre you enter. Note that the NEIGHBORS data (see Entering Spatial Data, page 53) must be entered for the MXCLRCUT option to be used. Furthermore, the use of MXCLRCUT implies the NOTEXACT option.

When the MXCLRCUT is specified, the model modifies the way it selects stands. If the subject stand's selection would result in the subject stand being clearcut, the model calculates the size of a contiguous clearcut under the assumption that the stand is selected. Contiguous stands that have already been selected and clearcut under the same policy are the stands that form the potential contiguous clearcut. If this contiguous area is greater than the maximum, the stand is not selected.

Definition of coordinated management areas comprising several stands may also influence the selection process. Stands with the same management identification codes form management areas unless the code is 'NONE', in which case each stand forms a unique management area (see the LDMGMTID keyword under Entering Spatial Data, page 54). Activating the use of coordinated management areas in the selection process is done using the CMUNIT option. A stand is selected using the priority scheme, as outlined above. If the stand is part of a management area, then other stands in the same unit are selected next in priority order.

Note that the MXCLRCUT and CMUNIT keywords may be used together, or one can be used without the other. The use of policy hierarchies is also independent of CMUNIT. See page 24 for another description of the selection process.

MSPOLICY   Signal that a multistand treatment policy will be entered.

field 1: Enter the policy number. If blank, the PPE assigns the next available number. If the entry contains a number that has already been used, the old policy definition is replaced.

field 2: Enter any number to indicate that you want reports printed for this policy; default is no reports.

field 3: Enter the initial value of OLDTARG, a variable that can be used in the target expression.

field 4: Enter any number to indicate that you want a policy hierarchy; field 1 must be 1 or 2 (see bottom of page 24).

field 5: Enter any number to indicate that you want the debug output printed (this is a lot of output designed to be read by system programmers); default is no debug output.

Supplemental data records:

TARGET = Enter an algebraic expression that defines the policy target. The expression may contain variables listed in table 1, constants, and all operators used in the Event Monitor except logical operators. Rules for coding expressions described for the Event Monitor apply.

PRIORITY = Enter an algebraic expression that defines stand selection priorities. The expression may contain variables that may be used in Event Monitor expressions except those defined only after thinning each cycle. The PRIORITY for selecting a stand may be a function of variables defined using the COMPUTE facility. For example, you may define the variable ENTERED as being equal to 0.0 if the stand has never been entered and equal to 1.0 once the stand has been entered. The value of ENTERED may then be used in computing the PRIORITY.

If variables defined using the COMPUTE facility are used in PRIORITY expression, the MSPOLICY keyword must be entered after the last ADDSTAND and before the PROJECT keyword. User-defined variables used in the PRIORITY expression must be appropriately defined for all of the stands that may contribute toward the harvest target. Furthermore, **you must specify user-defined variables in the same order for every stand** if you use them in the PRIORITY function. The PPE does not ensure that user-defined variables that are used in the PRIORITY expression hold to these rules.

CREDIT = Enter an algebraic expression that defines the method used to calculate each stand's

contribution toward meeting the target. The expression may contain Event Monitor variables, constants, and operators other than logical operators. Rules for coding expressions described for the Event Monitor apply. If user-defined variables are used, you must take the same precautions outlined for the PRIORITY expression.

MSPLABEL= Enter the policy label; see the section "Multistand Policy Labels," page 26, and below for details.

END End of the supplemental data records.

DEFCCUT A clearcut is a stand that has a top height that is less than the height coded on field 1 of this keyword *and* has less than the number of trees per acre coded on field 2.

field 1: Enter the top height that must be exceeded if a stand is considered "not clearcut"; default is 10 feet.

field 2: Enter the density that must be exceeded if a stand is considered "not clearcut"; default is 60 trees per acre.

EXACT
NOTEXACT Signal that the PPE should exactly meet the target by selecting partial stands (EXACT is the default), or should meet the target on the average and only cut complete stands.

MXCLRCUT Activate the maximum clearcut constraint logic.

field 1: Maximum clearcut size in acres.

CMUNIT
NOCMUNIT Activate the coordinated management unit logic for selecting stands.

Table 1—Variables that can be used in the TARGET expression

Variable name	Description
AVBTPA	Before thinning trees per acre averaged over all stands that can contribute toward the policy.
AVBTCUFT	Before thinning total cubic volume per acre averaged over all stands that can contribute toward the policy.
AVBMCUFT	Before thin merchantable cubic volume per acre averaged over all stands that can contribute toward the policy.
AVBBDFT	Before thin Scribner board foot volume per acre averaged over all stands that can contribute toward the policy.
AVBBA	Before thin basal area (ft^2/acre) averaged over all stands that can contribute toward the policy.
AVACC	Accretion (total ft^3/acre/year) from the previous cycle averaged over all stands that can contribute toward the policy.
AVMORT	Mortality (total ft^3/acre/year) from the previous cycle averaged over all stands that can contribute toward the policy.
MSPERIOD	The length (years) of the current master cycle.
TOTALWT	Total of the PPE stand weighting factors over all stands that can contribute toward the policy.
OLDTARG	The value of the target in the previous period.

Coding Multistand Policy Labels—A multistand policy label is the name of the policy. See the section "Multistand Policy Labels," page 26, for a detailed description of how policy labels work. Follow these rules when coding labels:

1. The name can contain two parts, separated by a period, such as: *intensive.early accelerated.* Unlike stand policy label sets, these policy label sets may contain only one label; that is, you may not list several policy names separated by commas.

2. The multistand policy label may be up to 40 characters long; lower case letters are converted to upper case letters; any characters other than commas and ampersands are allowed.

3. All policy labels must be unique. However, the first part of the label may be the same for several policies. A policy that has the same label as another policy will be ignored.

4. A stand label set must contain a policy label that matches the first part of the harvest policy label or else the stand's resource will not contribute to meeting the target of that policy.

Example 4: Harvest Scheduling—One of the primary uses for the multistand treatment scheduling is to generate timing alternatives for harvest scheduling. The yield tables generated for each alternative would be entered into a linear programming model, or some other system, for selecting which alternative to implement. To illustrate this application, the same collection of 119 stands from the Nez Perce National Forest used in the multistand treatment scheduling example under "What the PPE Does," page 3, are simulated under six harvest timing alternatives. The major difference between this example and the earlier one is that the hierarchy facility that allocated stands for use as cover is not used here.

The basic target formula is the Austrian formula as described in the earlier example. Table 2 lists multipliers used to double or triple the targeted yield in some decades and set it to zero in others, thereby creating the timing alternatives.

The priority scheme works like this: stands that have the most volume have the highest priority for selection except that the formula gives half as much weight to volume in stands that have been selected once. If a stand that has been selected has 2,000 board feet per acre, its priority is 1,000; if the stand had not been selected its priority would be 2,000. A user-defined variable called MANAGED was defined using the Event Monitor's COMPUTE option (see p. 5, Crookston 1990). This variable was set equal to 0.0 initially and to 1.0 once the stand was harvested. It was then used in the priority formula. Using a user-defined variable required that the harvest

Table 2—Multipliers used to generate timing alternatives in Example 4: Harvest Scheduling

Policy	Decade											
	1	2	3	4	5	6	7	8	9	10	11	12
TIMBER.1	Not applicable, 1 is assumed for all decades.											
TIMBER.2	0	0	2	2	0	0	2	2	0	0	2	2
TIMBER.3	2	2	0	0	2	2	0	0	2	2	0	0
TIMBER.4	3	0	0	3	0	0	3	0	0	3	0	0
TIMBER.5	0	3	0	0	3	0	0	3	0	0	3	0
TIMBER.6	0	0	3	0	0	3	0	0	3	0	0	3

policies be entered after the stands were entered so that the PPE could recognize the variable as a legal one.

The MXCLRCUT option was set at 40 acres.

The silvicultural prescriptions are the same as those in the example described under "What the PPE Does." To see exactly how the prescriptions were stated, read through the keyword file found in appendix D. This keyword file is quite long and includes comments describing the keywords and the approach used. At this point you should be able to read and understand the keyword file without further explanation, and there is no substitute for studying it. The keywords needed for entering each stand and the spatial data are not included. However, you will find the keywords used to generate output yield tables at the end of the file. The complete file is available from the authors in machine-readable format.

Example 4: Output and Discussion—Figure 19 plots harvested volume per decade (A-C), treated area (D), and standing volume (E) for policies 1, 3, and 5. Recall that the run scenario was to provide "timing" alternatives for entering the area. This objective was basically met. As you can see, each policy provides a different solution for harvesting this example collection of stands. While different from each other, each solution is specific as to silviculture and harvest timing down to the stand level. The individual yield tables and activity schedule for each stand can be output in line printer and machine-readable format for use in decision making.

The policy *Timber.1* delivers a rather consistent flow that appears to increase over projection period. Note that the percentage of the area that is in need of treatment each decade increases for all three policies. Both *Timber.3* and *Timber.5* provide some pulses of timber on two timing intervals. However, both of these options require operating in a larger and larger portion of the area (fig. 19D), and leave smaller residual volumes (fig. 19E).

A reason for the increases in percentage area treated, under *Timber.3* and *Timber.5*, is that the maximum clearcut of 40 acres is smaller than some of the stands. When the large stands matured and reached high selection priorities, the clearcut constraint blocked them from being harvested. These stands need to be split to make this run more meaningful. However, the example illustrates what happens when productive forest land is included in the targeted cut, but at the same time it is constrained from being harvested. Many acres and some lower priority stands were harvested in order to reach the target.

The PPE simulates the growth, development, and, through the stand and multistand treatment policies, the management of stands. However, managers do not often treat stands; they treat harvest units. Coordinated management units can be used to modify the PPE's scheduling logic. One way to solve the problem of including stands that are larger than the maximum clearcut constraint and solve the problem of management being directed at the wrong land unit is to process the input data, defining appropriate coordinated management units and splitting large stands, prior to the PPE model run.

A major reason for including this example is to illustrate the PPE's multistand treatment scheduling feature. In doing so, an application of the system is presented. Less clearly illustrated are the limitations on the system. The process of selecting stands according to priority order may not prove useful in some cases. Other approaches, such as providing a powerful rule-based system of selecting stands, may be needed.
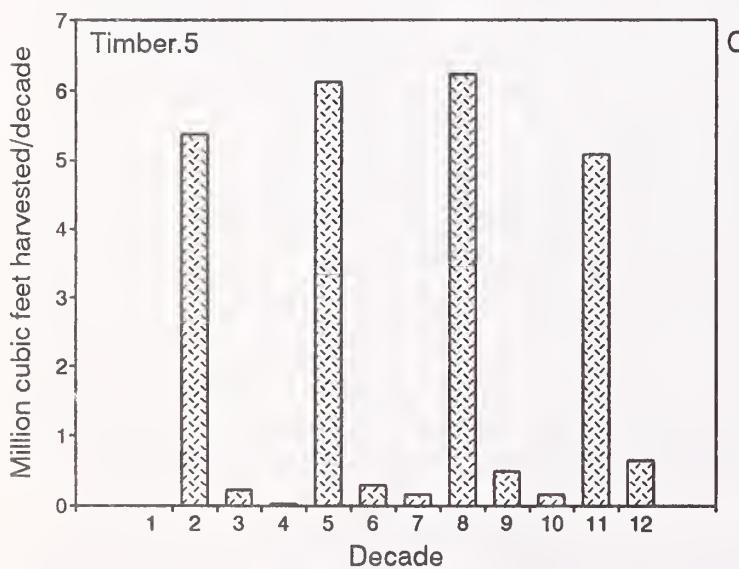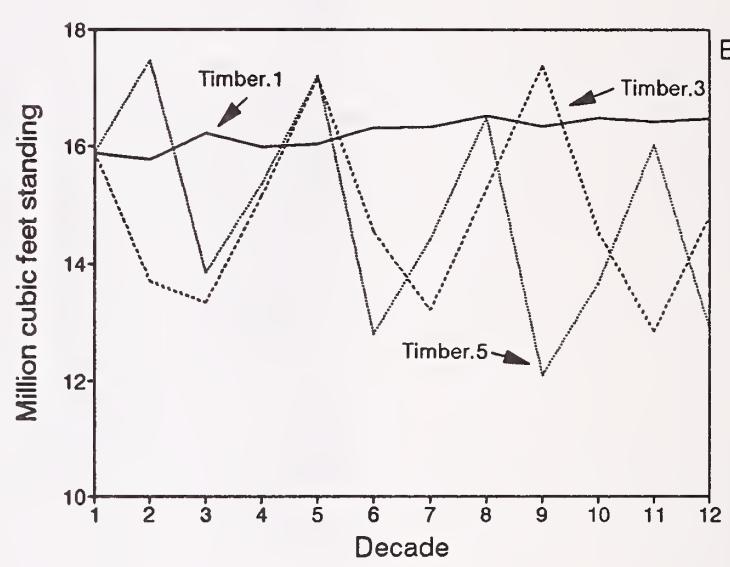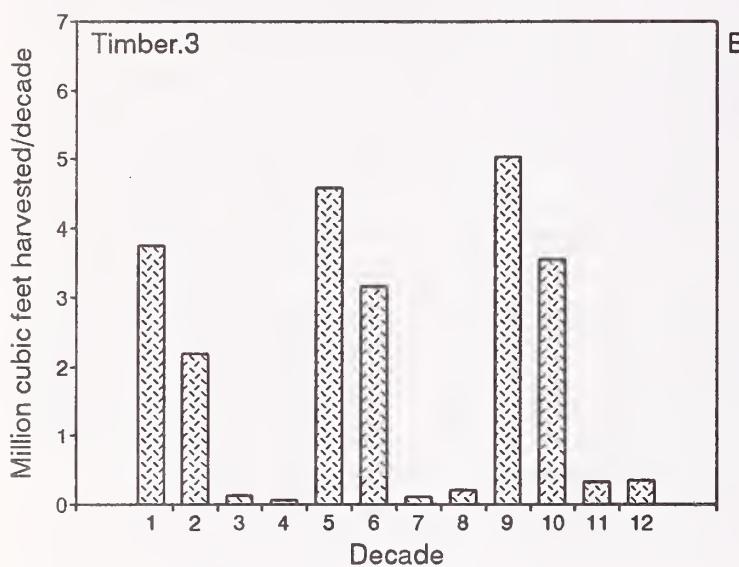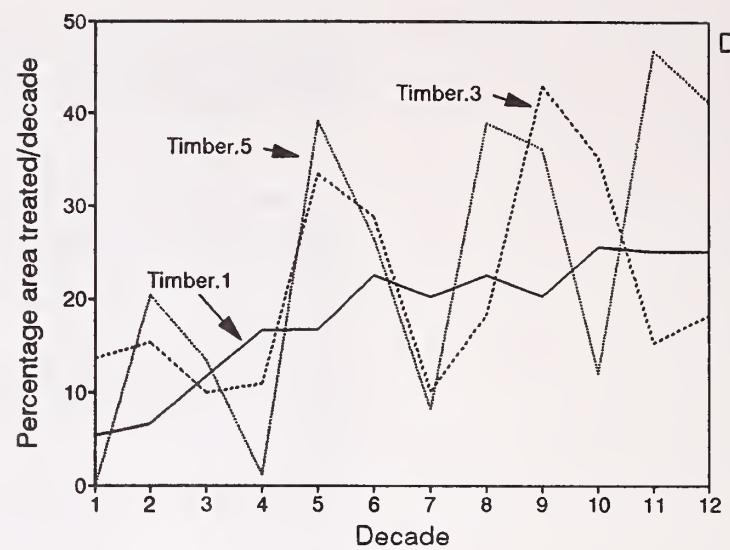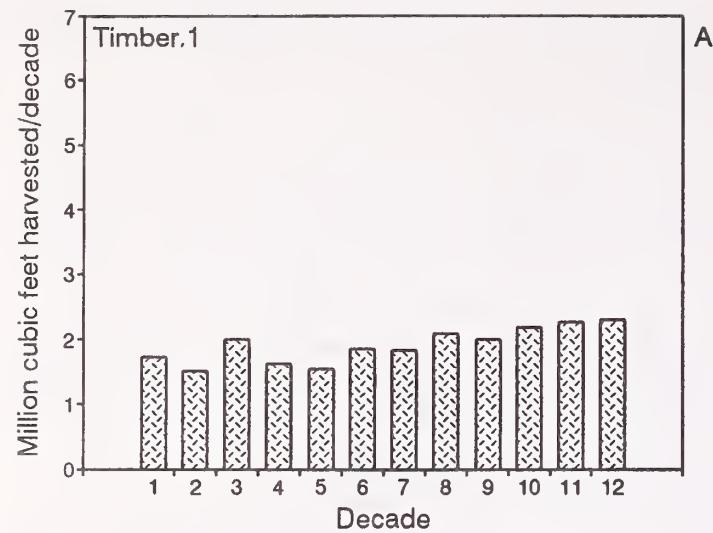
Figure 19—Harvest scheduling for 119 stands representing 3,266 acres, Nez Perce National Forest, ID. (A, B, C) Harvest volume/decade for three of the six timing alternatives from Example 4. (D) Percentage of the total area that is treated/decade. The treatment area generally increases over time. (E) Standing volume for the same three timing alternatives.

Entering Spatial Data

Spatial data are used by the PPE's multistand policy logic and extensions that represent insect pests. It is likely that other extensions will be developed in the future that use spatial data. Currently, four files containing spatial data useful to the PPE can be entered. The first file contains stand areas and locations of the stand centroids (AREALOCS), the second contains data describing which stands are neighbors of other stands (NEIGHBOR), the third allows redefinition of the stand management identifications so that they can be used to define coordinated management areas (LDMGMTID), and the fourth lists indices of access (for example, the distances from each stand to a road) for each stand (RDACCESS).

None of these files are required to use the PPE; they are required only if you need to use the data they contain to solve your problems.

Any of the spatial data may be reentered after a PAUSE. Therefore, the values these data take on may change through time. This facility is probably most useful for modifying the road access file through time.

Areas and Centroids—The area data may be entered without the centroid data, or visa versa. The area information is critical to harvest simulation and to the Mountain Pine Beetle and Budworm Models. These two insect models also use the centroid data.

AREALOCS   Signal that the stand areas and locations are to be read from the data set referred to by the number in field 1. If a negative number is entered, any currently stored data are forgotten. Records need not be in sorted order.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the location data to meters (UTM coordinates); default is 1.0.

field 3: A multiplier used to scale the area data to acres; default is 1.0.

Supplemental data records:

cols 1-8:   The stand identification code. If blank, the record is ignored. If "–999" is coded anywhere in columns 1-8, end-of-file is assumed.

cols 11-20: The east-west coordinate of the stand centroid. If blank, the location datum is not saved.

cols 21-30: The north-south coordinate of the stand centroid. If blank, the location datum is not saved.

cols 31-40: The area of the stand. If blank, the area is not saved.

Neighbors—The neighbors file can be used to enter data describing which stands are neighbors of other stands and, optionally, the length of common boundaries between the neighbors. These data are used in computing the size of maximum contiguous clearcuts, and they are used by the Mountain Pine Beetle Model.

NEIGHBOR   Signal that the neighbors file is to be read from the data referred to by the number in field 1. If a negative number is

entered, any currently stored data are forgotten. Records need not be in sorted order.

Several records for each stand may be entered. If more than one record for a stand pair is present in the file, the distances are added together. Therefore, if two stands share common borders in different places, each border segment is entered into the file and the program adds them together. Note that every line segment on a stand map can be represented only once in the file or else the length of the common boundary between stands will be inaccurate. However, if every line segment is represented exactly twice, the data may be corrected by coding 0.5 in field 2.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the border length data to meters; default is 1.0.

Supplemental data records:

cols 1-8: One stand identification code. If blank, the record is ignored. If "–999" is coded anywhere in columns 1-8, end-of-file is assumed.

cols 11-20: A neighboring stand identification code. If blank, the record is ignored.

cols 21-30: The length of the boundary between the two stands. If blank, the stands are considered neighbors that touch at one point.

Defining Coordinated Management Units—A coordinated management unit is defined within the PPE as a group of stands that carry the same management identification code. An exception is when the code NONE is used, in which case stands form unique management areas. The Prognosis Model keyword MGMTID is useful for entering the code along with other stand data. However, you may want to change the management identification codes for all or part of the stands in a run without modifying the keyword file; or in the case of a partial run that has been paused, you may want to modify them without restarting the run. This can be done using the LDMGMTID keyword. Note that this option will work properly only if it is used after all of the stands it applies to have been entered into the PPE. The records need not be in sorted order.

LDMGMTID Signal that a list of stand identifications and corresponding management identification codes be read from the dataset referred to by the number in field 1. If "–999" appears in columns 1-8 it is interpreted as end-of-data.

field 1: The data set reference number of the stand and new management identifications.

Supplemental data records:

cols 1-8: The stand identification code. If blank, the record is ignored.

cols 10-13: The new management identification code.

Road Access—A road access file is used to enter data that define the Event Monitor RDACCESS variable. These data may be the distances from stands to roads, measures of the cost of building roads from stands to the existing roads, hauling costs, or some other indices of access. Because the way these data are used is defined by the expressions you code, you also define the units of measure.

RDACCESS   Signal that access file be read from the data set referenced by the number in field 1. If a negative number is entered, any currently stored data are forgotten. Records need not be in sorted order.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the access data.

Supplemental data records:

cols 1-8:   The stand identification code. If blank, the record is ignored. If "–999" is coded anywhere in columns 1-8, end-of-file is assumed.

cols 11-20:   The accessibility index for the stand.

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APPENDIX A: OUTPUT FROM EXAMPLE 1

```
                    Column Rule
....+....1....+....2....+....3....+....4....+....5
101001      11LP  115 10 73   0    04 0 0 0 0 0 011
101002      31DF    1  0  2   0    06 0 0 0 0 0 022
102003      11WH   65 23 30   0    08 0 0 0 0 0 011
102004      11L    79  6 75   0    03 0 0 0 0 0 011
102005      18L   346  0  0   0    0010 0 0 0 0 032
103006      11L    80  7 63  56    0396 0 0 0 0 022
103007      11GF   62 20 38   0    05 0 0 0 0 0 011
103008      11L    84  0  5   0    04 0 0 0 0 0 011
103009      11LP   95 11 60   0    03 0 0 0 0 0 011
104010      11DF   40  0 20   0   503 0 0 0 0 0 011
104011      11L    82 12 65   0    0550 0 0 0 0 011
105012      11DF   12  0 11   0   426 0 0 0 0 0 022
105013      11DF   19  0 13   0   475 0 0 0 0 0 022
105014      16LP   72  0  0   0    0011 0 0 0 0 032
105015      31GF    1  0  3   0    07 0 0 0 0 0 022
105016      11GF   53  9 27   0    07 0 0 0 0 0 011
-999
106001      11DF  100 10 65   0    04 0 0 0 0 0 011
106002      11GF   61 12 38   0    08 0 0 0 0 0 011
106003      11DF  127 16 67   0    04 0 0 0 0 0 011
107004      00      0  0  0   0    00 0 0 0 0 0 080
108005      11LP   96  5 60   0    03 0 0 0 0 0 022
108006      11DF  104  9 55  49    0597 0 0 0 0 022
108007      11LP   85  0  0   0    03 0 0 0 0 0 011
109008      11GF  109 10 65   0    07 0 0 0 0 0 011
109009      11DF   94 18 60   0    04 0 0 0 0 0 011
110010      11C    32  6 17   0   325 0 0 0 0 0 022
110011      11C     1  0  2   0    07 0 0 0 0 0 022
110012      11C    58 10 28   0    07 0 0 0 0 0 011
110013      11C    50 10 25   0   373 0 0 0 0 0 011
111014      11GF   66 14 30   0    07 0 0 0 0 0 011
```

Example 1, Input tree data file.

OPTIONS SELECTED BY INPUT

KEYWORD	PARAMETERS:

STARTYR   MASTER STARTING YEAR= 1990

MSTRINT   MASTER CYCLE= 1; PERIOD LENGTH= 20

MSTRINT   MASTER CYCLE= 2; PERIOD LENGTH= 30

MSTRCYCS   NUMBER OF MASTER CYCLES= 2

ADDSTAND   ADD ONE STAND TO THE DATA BASE.

STDIDENT
           STAND ID= STAND1

INVYEAR   INVENTORY YEAR= 1978

TREEDATA   DATA SET REFERENCE NUMBER= 2

PROCESS   PROCESS THE STAND.

OPTIONS SELECTED BY DEFAULT

TREEFMT   (I4,T1,I7,F6.0,I1,A3,F4.1,F3.1,2F3.0,F4.1,I1,3(I2,I2),2I1,I2,2I3,2I1)

DESIGN   BASAL AREA FACTOR= 40.0; INVERSE OF FIXED PLOT AREA= 300.0; BREAK DBH=   5.0
           NUMBER OF PLOTS=   5; NON-STOCKABLE PLOTS=   0; STAND SAMPLING WEIGHT=   5.00000

STDINFO   FOREST-LOCATION CODE=   118; HABITAT TYPE= 0; AGE=   0; ASPECT AZIMUTH IN DEGREES=   0.; SLOPE=   5.%
           ELEVATION(100'S FEET)= 38.0; LATITUDE IN DEGREES= 45.

********   SPS14 WARNING: HABITAT CODE WAS NOT RECOGNIZED; HABITAT TYPE SET TO DEFAULT CODE.
           HABITAT TYPE MAPPED TO 260 FOR THIS PROJECTION.

ACTIVITY SCHEDULE

STAND ID= STAND1   MANAGEMENT ID= NONE

CYCLE	DATE	EXTENSION	KEYWORD	DATE	PARAMETERS:
1	1978				
2	1990				
3	2000				
4	2010				
5	2020				
6	2030				

Example 1, Step 1, output (con.)

CALIBRATION STATISTICS:

	LP	DF	WH	L	GF
NUMBER OF RECORDS PER SPECIES	3	4	1	4	3
NUMBER OF RECORDS CODED AS RECENT MORTALITY	1	0	0	0	0
NUMBER OF RECORDS WITH MISSING HEIGHTS	0	0	0	0	0
NUMBER OF RECORDS WITH BROKEN OR DEAD TOPS	0	0	0	1	0
NUMBER OF RECORDS WITH MISSING CROWN RATIOS	0	0	0	0	0
NUMBER OF RECORDS AVAILABLE FOR SCALING THE DIAMETER INCREMENT MODEL	2	0	1	3	2
RATIO OF STANDARD ERRORS (INPUT DBH GROWTH DATA : MODEL)	1.00	1.00	1.00	1.00	1.00
WEIGHT GIVEN TO THE INPUT GROWTH DATA WHEN DBH GROWTH MODEL SCALE FACTORS WERE COMPUTED	.00	.00	.00	.00	.00
INITIAL SCALE FACTORS FOR THE DBH INCREMENT MODEL	1.00	1.00	1.00	1.00	1.00
NUMBER OF RECORDS AVAILABLE FOR SCALING THE SMALL TREE HEIGHT INCREMENT MODEL	0	3	0	0	0
INITIAL SCALE FACTORS FOR THE SMALL TREE HEIGHT INCREMENT MODEL	1.00	1.00	1.00	1.00	1.00

SUMMARY UP TO MASTER STARTING YEAR:

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD									REMOVALS				AFTER TREATMENT					GROWTH THIS PERIOD			
YEAR	AGE	NO OF TREES	BA	SDI	CCF	TOP HT	QMD	TOTAL CU FT	MERCH CU FT	MERCH BD FT	NO OF TREES	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA	SDI	CCF	TOP HT	RES QMD	PERIOD YEARS	ACCRE PER	MORT YEAR	MAI MERCH CU FT
1978	0	781	79	201	96	46	4.3	1479	985	4310	0	0	0	0	79	201	96	46	4.3	12	97	13	.0
1990	12	591	79	268	96	46	4.3	2484	2087	8605	0	0	0	0	120	268	144	58	6.1	0	0	0	.0

Example 1, Step 1, output (con.)

OPTIONS SELECTED BY INPUT

KEYWORD   PARAMETERS:
--------   --

ADDSTAND   ADD ONE STAND TO THE DATA BASE.

STDIDENT
           STAND ID= STAND2

INVYEAR   INVENTORY YEAR= 1984

TREEDATA   DATA SET REFERENCE NUMBER= 2

PROCESS   PROCESS THE STAND.

OPTIONS SELECTED BY DEFAULT

TREEFMT   (I4,T1,I7,F6.0,I1,A3,F4.1,F3.1,2F3.0,F4.1,I1,3(I2,I2),2I1,I2,2I3,2I1)

DESIGN   BASAL AREA FACTOR= 40.0; INVERSE OF FIXED PLOT AREA= 300.0; BREAK DBH=   5.0
           NUMBER OF PLOTS=   6; NON-STOCKABLE PLOTS=   1; STAND SAMPLING WEIGHT=   6.00000
           STAND ATTRIBUTES ARE CALCULATED PER ACRE OF STOCKABLE AREA. STAND STATISTICS
           IN SUMMARY TABLE ARE MULTIPLIED BY .833 TO INCLUDE TOTAL STAND AREA.

STDINFO   FOREST-LOCATION CODE=   118; HABITAT TYPE= 0; AGE=   0; ASPECT AZIMUTH IN DEGREES=   0.; SLOPE=   5.%
           ELEVATION(100'S FEET)= 38.0; LATITUDE IN DEGREES= 45.

********   SPS14 WARNING: HABITAT CODE WAS NOT RECOGNIZED; HABITAT TYPE SET TO DEFAULT CODE.
           HABITAT TYPE MAPPED TO 260 FOR THIS PROJECTION.

ACTIVITY SCHEDULE

STAND ID= STAND2   MANAGEMENT ID= NONE

CYCLE DATE EXTENSION KEYWORD   DATE PARAMETERS:
----- ---- --------- -------- ---- --

   1   1984
   2   1990
   3   2000
   4   2010
   5   2020
   6   2030

Example 1, Step 1, output (con.)

```
CALIBRATION STATISTICS:

                                                DF    GF    LP    C
                                                ----  ----  ----  ----

NUMBER OF RECORDS PER SPECIES                    4     3     2     4

NUMBER OF RECORDS WITH MISSING HEIGHTS           0     0     1     0

NUMBER OF RECORDS WITH BROKEN OR DEAD TOPS       1     0     0     0

NUMBER OF RECORDS WITH MISSING CROWN RATIOS      0     0     0     0

NUMBER OF RECORDS AVAILABLE FOR SCALING
THE DIAMETER INCREMENT MODEL                     4     3     1     2

RATIO OF STANDARD ERRORS
(INPUT DBH GROWTH DATA : MODEL)                 1.00  1.00  1.00  1.00

WEIGHT GIVEN TO THE INPUT GROWTH DATA WHEN
DBH GROWTH MODEL SCALE FACTORS WERE COMPUTED     .00   .00   .00   .00

INITIAL SCALE FACTORS FOR THE
DBH INCREMENT MODEL                             1.00  1.00  1.00  1.00

NUMBER OF RECORDS AVAILABLE FOR SCALING
THE SMALL TREE HEIGHT INCREMENT MODEL            0     0     0     1

INITIAL SCALE FACTORS FOR THE SMALL TREE
HEIGHT INCREMENT MODEL                          1.00  1.00  1.00  1.00
```

SUMMARY UP TO MASTER STARTING YEAR:

```
                          SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)
-----------------------------------------------------------------------------------------------------------------------
          START OF SIMULATION PERIOD                      REMOVALS          AFTER TREATMENT   GROWTH THIS PERIOD
        ------------------------------------------  ----------------------  ----------------  ------------------     MAI
        NO OF                   TOP       TOTAL MERCH MERCH NO OF TOTAL MERCH MERCH          TOP  RES PERIOD ACCRE MORT MERCH
YEAR AGE TREES  BA  SDI CCF HT  QMD  CU FT CU FT BD FT TREES CU FT CU FT BD FT  BA  SDI CCF HT  QMD  YEARS  PER  YEAR CU FT
---- --- -----  --  --- --- --- ---- ----- ----- ----- ----- ----- ----- ----- --- --- --- --- ---- ------ ---- ----- -----
1984  0   332   76  165  95  62 6.5  1567  1145  4306    0     0     0     0   76  165  95  62 6.5     6    89   13   .0
1990  6   318   76  195  95  62 6.5  2019  1671  6604    0     0     0     0   94  195 115  68 7.4     0     0    0   .0
```

```
              STAND GROWTH PROGNOSIS SYSTEM     VERSION 6.10 -- INLAND EMPIRE          04-17-1991  09:57:34
                            PARALLEL PROCESSING EXTENSION -- VERSION 1.0
-----------------------------------------------------------------------------------------------------------------------

                                        OPTIONS SELECTED BY INPUT
-----------------------------------------------------------------------------------------------------------------------
KEYWORD    PARAMETERS:
-------    ------------------------------------------------------------------------------------------------------------

PROJECT    THERE ARE   2 STANDS TO PROJECT.
-----------------------------------------------------------------------------------------------------------------------


              STAND GROWTH PROGNOSIS SYSTEM     VERSION 6.10 -- INLAND EMPIRE          04-17-1991  09:57:38
                            PARALLEL PROCESSING EXTENSION -- VERSION 1.0
-----------------------------------------------------------------------------------------------------------------------

                                        OPTIONS SELECTED BY INPUT
-----------------------------------------------------------------------------------------------------------------------
KEYWORD    PARAMETERS:
-------    ------------------------------------------------------------------------------------------------------------

PAUSE
-----------------------------------------------------------------------------------------------------------------------
```

Example 1, Step 1, output

OPTIONS SELECTED BY INPUT

KEYWORD   PARAMETERS:
-------   --

RESTORE   RESTORE PARALLEL PROCESSING MEMORY.

NOSUM   SUMMARY DATA WILL NOT BE PRINTED.

NOACTSUM   ACTIVITY SUMMARIES WILL NOT BE PRINTED.

YIELDS   PROCESS YIELD TABLES.

NOTE: PROCESSING STAND NUMBER: 1 STAND ID: STAND1   MGMT ID (AS INPUT): NONE PPE STAND WEIGHTING FACTOR: .5000000E+01

NOTE: PROCESSING STAND NUMBER: 2 STAND ID: STAND2   MGMT ID (AS INPUT): NONE PPE STAND WEIGHTING FACTOR: .6000000E+01

COMPOSITE YIELD STATISTICS

		VOLUME PER ACRE			REMOVALS/TREATED ACRE					AVE	GROWTH			TOTAL	FRACTION	
		TREES	TOTAL	MERCH	MERCH	TREES	TOTAL	MERCH	MERCH	BA/ ACRE		DOM HT	PRD	ACC	MOR	SAMPLE	OF AREA	MGMT
YEAR	AGE	/ACRE	CU FT	CU FT	BD FT	/ACRE	CU FT	CU FT	BD FT	SQFT	CCF	FT	YRS	CUFT/YR		WEIGHT	TREATED	ID
1978	0	781	1479	985	4310	0	0	0	0	79	96	46	12	97	13	5	.000000	NONE
1984	0	332	1567	1145	4306	0	0	0	0	76	95	62	6	89	13	6	.000000	NONE
1990	9	442	2230	1860	7514	0	0	0	0	106	128	63	10	116	23	11	.000000	NONE
2000	19	398	3164	2803	11843	0	0	0	0	137	157	72	10	151	34	11	.000000	NONE
2010	29	362	4337	3997	18229	0	0	0	0	165	179	82	10	157	49	11	.000000	NONE
2020	39	307	5412	5091	24850	0	0	0	0	185	195	88	10	168	64	11	.000000	NONE
2030	49	259	6453	6138	31287	0	0	0	0	199	207	95	10	154	71	11	.000000	NONE
2040	59	236	7291	7010	36422	0	0	0	0	209	213	101	0	0	0	11	.000000	NONE

Example 1, Step 2, output

```
-------------------------------------------------------------------------------------------------
                                   OPTIONS SELECTED BY INPUT

-------------------------------------------------------------------------------------------------
KEYWORD     PARAMETERS:
-------     -----------------------------------------------------------------------------------

RESTORE     RESTORE PARALLEL PROCESSING MEMORY.

SELSTAND    STAND WITH STAND IDENTIFICATION= 'STAND2  ' WILL BE PROCESSED FOR OUTPUT.

NOSMPTRE    SAMPLE TREE AND STAND ARRTIBUTE TABLES WILL NOT BE PRINTED.

STNDTABS    PRINT STAND TABLES.
-------------------------------------------------------------------------------------------------
```

STAND ID: STAND2   MANAGEMENT CODE: NONE

STAND COMPOSITION (BASED ON STOCKABLE AREA)

YEAR	STAND ATTRIBUTES	PERCENTILE POINTS IN THE DISTRIBUTION OF STAND ATTRIBUTES BY DBH						TOTAL/ACRE OF STAND ATTRIBUTES	DISTRIBUTION OF STAND ATTRIBUTES BY SPECIES AND 3 USER-DEFINED SUBCLASSES			
		10	30	50	70	90	100					
		(DBH IN INCHES)										
1984	TREES	.1	3.2	5.8	6.6	10.0	12.7	398. TREES	30.% C2,	26.% C1,	21.% GF1,	10.% DF1
	VOLUME:											
	TOTAL	6.1	8.5	9.6	10.4	12.7	12.7	1880. CUFT	31.% DF1,	24.% GF1,	14.% LP1,	13.% LP2
	MERCH	8.5	9.6	10.0	10.4	12.7	12.7	1374. CUFT	40.% DF1,	17.% LP1,	16.% LP2,	15.% GF1
	MERCH	8.5	9.6	10.0	10.9	12.7	12.7	5167. BDFT	40.% DF1,	18.% LP2,	16.% GF1,	15.% LP1
	ACCRETION	5.8	6.1	8.5	10.0	10.9	12.7	107. CUFT/YR	45.% GF1,	22.% DF1,	14.% C1,	7.% DF2
	MORTALITY	6.6	8.5	9.6	9.6	10.9	12.7	16. CUFT/YR	29.% LP1,	25.% LP2,	23.% DF1,	13.% GF1
1990	TREES	.7	4.3	6.9	7.9	10.9	14.1	382. TREES	30.% C2,	26.% C1,	22.% GF1,	10.% DF1
	VOLUME:											
	TOTAL	7.0	8.8	10.2	11.4	13.2	14.1	2422. CUFT	30.% GF1,	29.% DF1,	11.% LP1,	10.% LP2
	MERCH	7.9	9.2	10.5	11.4	13.2	14.1	2005. CUFT	33.% DF1,	32.% GF1,	12.% LP1,	12.% LP2
	MERCH	7.9	9.9	10.8	11.8	13.2	14.1	7925. BDFT	33.% DF1,	31.% GF1,	12.% LP1,	12.% LP2
	ACCRETION	6.9	7.6	8.7	10.9	13.2	14.1	123. CUFT/YR	50.% GF1,	19.% DF1,	15.% C1,	6.% DF2
	MORTALITY	7.5	8.9	10.0	10.5	12.3	14.1	27. CUFT/YR	24.% DF1,	23.% LP1,	20.% LP2,	20.% GF1
2000	TREES	1.0	6.0	8.5	9.8	12.6	17.4	345. TREES	30.% C2,	27.% C1,	22.% GF1,	10.% DF1
	VOLUME:											
	TOTAL	8.5	10.0	11.2	13.1	15.7	17.4	3385. CUFT	38.% GF1,	26.% DF1,	12.% C1,	8.% DF2
	MERCH	9.4	10.7	11.5	13.3	15.7	17.4	3027. CUFT	40.% GF1,	28.% DF1,	9.% C1,	8.% DF2
	MERCH	9.4	10.9	12.1	14.0	15.8	17.4	12727. BDFT	41.% GF1,	28.% DF1,	9.% DF2,	8.% C1
	ACCRETION	8.5	9.7	10.9	12.4	14.4	17.4	158. CUFT/YR	59.% GF1,	16.% C1,	13.% DF1,	6.% DF2
	MORTALITY	8.5	9.8	11.0	12.4	14.7	17.4	32. CUFT/YR	30.% GF1,	24.% DF1,	15.% LP1,	14.% LP2
2010	TREES	.1	4.4	7.7	11.3	14.5	19.6	383. TREES	24.% C2,	24.% C1,	23.% GF1,	18.% DF1
	VOLUME:											
	TOTAL	9.9	12.2	13.3	15.1	16.7	19.6	4639. CUFT	46.% GF1,	22.% DF1,	14.% C1,	7.% DF2
	MERCH	10.0	12.4	13.7	15.1	17.1	19.6	4306. CUFT	48.% GF1,	22.% DF1,	12.% C1,	7.% DF2
	MERCH	10.5	12.6	14.0	15.5	17.1	19.6	19507. BDFT	50.% GF1,	22.% DF1,	10.% C1,	8.% DF2
	ACCRETION	9.6	12.2	13.2	14.0	16.7	19.6	160. CUFT/YR	59.% GF1,	22.% C1,	11.% DF1,	3.% DF2
	MORTALITY	9.9	11.2	12.7	15.0	16.7	19.6	47. CUFT/YR	37.% GF1,	22.% DF1,	12.% LP1,	11.% C1

(Several lines are not shown)

YEAR	STAND ATTRIBUTES	10	30	50	70	90	100	TOTAL/ACRE				
2040	TREES	1.3	7.2	11.3	15.7	20.5	28.9	248. TREES	26.% C2,	26.% C1,	21.% GF1,	19.% DF1
	VOLUME:											
	TOTAL	12.8	17.2	19.0	21.3	24.6	28.9	8032. CUFT	58.% GF1,	18.% C1,	14.% DF1,	4.% DF2
	MERCH	12.9	17.2	19.0	21.3	24.6	28.9	7728. CUFT	58.% GF1,	17.% C1,	14.% DF1,	4.% DF2
	MERCH	14.3	17.4	19.2	21.3	24.6	28.9	39277. BDFT	63.% GF1,	14.% C1,	14.% DF1,	5.% DF2

Example 1, Step 3, output (con.)

PARALLEL PROCESSING EXTENSION -- VERSION 1.0

OPTIONS SELECTED BY INPUT

KEYWORD   PARAMETERS:
--------   --

NOSELECT   "SELECT" OPTIONS HAVE BEEN TURNED OFF.

NOCOMPOS   COMPOSITE YIELD TABLES WILL NOT BE GENERATED.

YIELDS   PROCESS YIELD TABLES.

STAND GROWTH PROGNOSIS SYSTEM   VERSION 6.10 -- INLAND EMPIRE   04-17-1991 12:07:22

NOTE: PROCESSING STAND NUMBER: 1 STAND ID: STAND1   MGMT ID (AS INPUT): NONE PPE STAND WEIGHTING FACTOR: .5000000E+01

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD									REMOVALS				AFTER TREATMENT				GROWTH THIS PERIOD			MAI
		NO OF				TOP		TOTAL	MERCH	MERCH	NO OF	TOTAL	MERCH	MERCH				TOP	RES	PERIOD	ACCRE	MORT	MERCH
YEAR	AGE	TREES	BA	SDI	CCF	HT	QMD	CU FT	CU FT	BD FT	TREES	CU FT	CU FT	BD FT	BA	SDI	CCF	HT	QMD	YEARS	PER	YEAR	CU FT
----	---	-----	---	----	---	---	----	-----	-----	-----	-----	-----	-----	-----	---	----	---	---	----	------	----	-----	-----
1978	0	781	79	201	96	46	4.3	1479	985	4310	0	0	0	0	79	201	96	46	4.3	12	97	13	.0
1990	12	591	120	268	144	58	6.1	2484	2087	8605	0	0	0	0	120	268	144	58	6.1	10	131	22	.0
2000	22	529	155	321	179	67	7.3	3576	3140	13328	0	0	0	0	155	321	179	67	7.3	10	176	43	.0
2010	32	413	184	350	199	79	9.0	4903	4488	20597	0	0	0	0	184	350	199	79	9.0	10	185	62	.0
2020	42	356	201	366	209	88	10.2	6135	5746	28711	0	0	0	0	201	366	209	88	10.2	10	194	77	.0
2030	52	267	213	362	214	96	12.1	7306	6941	36161	0	0	0	0	213	362	214	96	12.1	10	150	80	.0
2040	62	270	217	368	214	100	12.1	8009	7695	40853	0	0	0	0	217	368	214	100	12.1	0	0	0	.0

STAND GROWTH PROGNOSIS SYSTEM   VERSION 6.10 -- INLAND EMPIRE   04-17-1991 12:07:22

NOTE: PROCESSING STAND NUMBER: 2 STAND ID: STAND2   MGMT ID (AS INPUT): NONE PPE STAND WEIGHTING FACTOR: .6000000E+01

SUMMARY STATISTICS (PER ACRE OR STAND BASED ON TOTAL STAND AREA)

		START OF SIMULATION PERIOD									REMOVALS				AFTER TREATMENT				GROWTH THIS PERIOD			MAI
		NO OF				TOP		TOTAL	MERCH	MERCH	NO OF	TOTAL	MERCH	MERCH				TOP	RES	PERIOD	ACCRE	MORT	MERCH
YEAR	AGE	TREES	BA	SDI	CCF	HT	QMD	CU FT	CU FT	BD FT	TREES	CU FT	CU FT	BD FT	BA	SDI	CCF	HT	QMD	YEARS	PER	YEAR	CU FT
----	---	-----	---	----	---	---	----	-----	-----	-----	-----	-----	-----	-----	---	----	---	---	----	------	----	-----	-----
1984	0	332	76	165	95	62	6.5	1567	1145	4306	0	0	0	0	76	165	95	62	6.5	6	89	13	.0
1990	6	318	94	195	115	68	7.4	2019	1671	6604	0	0	0	0	94	195	115	68	7.4	10	103	23	.0
2000	16	288	122	234	139	76	8.8	2821	2523	10606	0	0	0	0	122	234	139	76	8.8	10	131	27	.0
2010	26	319	150	283	163	84	9.3	3866	3588	16256	0	0	0	0	150	283	163	84	9.3	10	133	39	.0
2020	36	266	171	303	183	88	10.9	4809	4546	21633	0	0	0	0	171	303	183	88	10.9	10	147	54	.0
2030	46	252	188	324	201	94	11.7	5742	5469	27225	0	0	0	0	188	324	201	94	11.7	10	158	63	.0
2040	56	207	202	329	213	101	13.4	6693	6440	32730	0	0	0	0	202	329	213	101	13.4	0	0	0	.0

Example 1, Step 3, output

APPENDIX B: SPECIAL TOPICS

Label and Weights File

The label and weights file is a machine-readable file containing the PPE stand weighting factors for each stand, the list of activities that were accomplished during the simulation of growth for each stand, the stand policy labels, and the harvest policy labels for each stand. It is designed to be processed by another computer program that may extract and summarize this information as needed for other analyses. You control the creation of this file using the LABWTS keyword. The format of the output records is listed in table B-1.

Table B-1—Format of the label and weights file

Columns	Data type	Description
1-4	Character	User-specified label and weights file identification code (see the LABWTS keyword)
5-6		Reserved
7-18	Character	Internal stand number
19	Integer	Record type identification
when column 19 is 1 = PPE stand weighting factor record		
20-21	Integer	Record continuation sequence number
22		Reserved
23-30	Character	Stand identification
31-32		Reserved
33-36	Character	Management identification
37-40		Reserved
41-55	Real	PPE stand weighting factor written using FORTRAN format code E15.7
when column 19 is 2 = activity record		
22-25	Character	Extension code for the activity
26		Reserved
27-34	Character	Activity keyword for a completed activity
35		Reserved
36-39	Integer	Year activity was done
40		Reserved
41-50	Real	Value of field 1 for the activity
51-60	Real	Value of field 2 for the activity
61-70	Real	Value of field 3 for the activity
71-80	Real	Value of field 4 for the activity (if more than 4 fields are needed, a continuation record is used)
when column 19 is 3 = stand label set record		
22-24		Reserved
25-80	Character	Stand label set (continuation records are used if needed)
when column 19 is 4 = multistand policy label record		
20-21	Integer	Harvest policy number
25-64	Character	Harvest policy label

COVER Machine-Readable Output Format

The machine-readable COVER output is generated using the PPE CVOUTPUT keyword. This output is available for any stand in the run where the COVER options have been coded. Moeur (1985) has described the necessary keywords and the output generated from running this model. Some of the output items found in Moeur's output tables are repeated in the machine-readable output file in the format listed in table B-2.

Table B-2—Format of the Cover Machine-readable file

Columns	Data type	Reference pages in Moeur (1985)	Description
2-9	Character		Stand ID
11-14	Character		Management ID
16-19	Integer		Year
21	Integer		Harvest code, 1 = prethin and no-thin, 2 = postthin
22-24	Integer	11, 12	Time since disturbance
25-27	Integer	11, 12	Probability of shrub cover
28-30	Integer	11, 12	Percent low shrub cover
31-33	Integer	11, 12	Percent medium shrub cover
34-36	Integer	11, 12	Percent high shrub cover
37-39	Integer	11, 12	Percent total shrub cover
40-44	Real	11, 12	Average shrub height
45-50	Integer	11, 12	Dormant shrub biomass (pounds/acre)
51-55	Real	11, 12	Twigs (number per ft^2)
56-58	Integer	11, 12	Successional stage code
59-63	Integer	11, 12	Stand age (years)
64-68	Integer	11, 12	Top height (feet)
69-73	Integer	11, 12	Canopy closure (percent)
74-79	Integer	11, 12	Foliage biomass (pounds/acre)
80-84	Integer	11, 12	Sum of stem diameters (feet)
85-90	Integer	11, 12	Number of stems/acre
91-96	Integer	3, 5	Percent canopy closure 0-10-ft class
97-102	Integer	3, 5	Percent canopy closure 10-20-ft class
103-108	Integer	3, 5	Percent canopy closure total stand
110-120	Character		PPE internal stand number

CHEAPOII Machine-Readable Output Format

Horn and others (1986) wrote an economic analysis program that uses Prognosis Model outputs as a source of yield and activity data. The format of the yield portion of this file is outlined in table B-3. This file is produced by the Prognosis Model if the CHEAPO keyword is entered. Note that this output is generated on a stand-by-stand basis as the PPE run progresses. It is not stored by the PPE for outputting on command as is done for the COVER model. Therefore, the output organization will be in the order of computations that are to process all of the stands for one time step before processing the next time step. You must sort this file as necessary for your intended purpose. In addition, the activities are not output for this file when it is produced in a PPE run. The activities are output in machine-readable format using the LABWTS keyword. You must supply the necessary programs to merge these files as necessary for CHEAPOII analyses.

Note that you may find this file useful for purposes besides input for CHEAPOII. Other economic analysis procedures have used this output as a source of resource data.

Table B-3—Format of the CHEAPOII file

Columns	Data type	Description
1-4	Integer	Year
7-8	Integer	Prognosis species code
12-13	Integer	Diameter class (1-inch class)
14-20	Real	Total cubic feet/acre
21-27	Real	Merchantable cubic feet/acre
28-35	Real	Merchantable board feet/acre
36-44	Real	Trees/acre
45-51	Real	Basal area/acre
54	Integer	Harvest code: 1 = tree left standing 2 = tree was removed
60-62	Integer	Stand age
66-73	Character	Stand identification
75-78	Character	Management identification
81-91	Character	PPE internal stand number

History File: Uses and Format

The simulation history file is used by the program to journal the use of the print-data direct access file. One record is written for each stand for every Prognosis Model cycle. The PPE reads the history file when it is processing the STNDTABS option because the records contain pointers to the data needed to construct the stand table outputs.

The file may contain too many records for the PPE to hold in memory at one time, which is required when the program is processing the stand tables. In this case, you can break up the file into several small files, each containing all of the records for a group of one or more stands. You accomplish this task by (1) sorting the history file into ascending order on CISNUM, (2) splitting the file at a point where the first four characters of CISNUM change, and (3) processing each part separately. Use the READHIST, OPEN, and CLOSE keywords to control which history file is processed. The format of the file is described in table B-4.

Table B-4—Format of the history file data records

Columns	Variable name	Description
2-6	ISTND	Processing sequence number
8-22	CISNUM	Internal stand number
24-28	NAVPRT	Record pointer to the print-data file
29-34	IPTELS	Print-data version, programmers should see common area PPCNTL
36-40	ICYC	Prognosis Model cycle number

READHIST field 1: Dataset reference number of the History file. Used to cause the program to read the history file. A blank field leaves the default unchanged.

Debug

Programmers will find the DEBUG option useful because it causes the PPE to print a lot of detailed information about the processing within the PPE. If you want debug output, you must specify the DEBUG keyword while PPE keywords are being processed. Note that debug output is independently controlled for the Harvest Selection component; see the HARVEST keyword. Prognosis Model debug output is also independently controlled.

DEBUG
NODEBUG Control the printing of PPE debug output; NODEBUG is the default.

field 1: Enter a data set reference number for PPE and Prognosis Model output; a blank field leaves the default unchanged.

APPENDIX C: LABEL PROCESSING RULES

Rules for Stand Labels

The rules for processing labels described in the body of the guide are incomplete. This appendix supplies a complete description of the algorithm. Label processing governs two PPE and Prognosis Model processes. First, the Event Monitor uses label processing when decision trees are being formed and activity groups are being scheduled conditionally on the value of logical expressions. Second, the PPE uses label processing to control which stands are selected when multistand treatment policies are being simulated.

The rules and processing steps used by the Event Monitor are summarized below. The following definitions are necessary: A set of labels called the "stand label set" (SLS) contains the policy labels that are appropriate for the stand (see the SPLABEL keyword). Another set, called the "activity group label set" (AGLS), is the set of policy labels that are appropriate for the group of activities (see the AGPLABEL keyword).

1. Identify the SLS for the stand and set the AGLS for any activity groups for which no set was specified:

    a. The user may specify the SLS.

    b. The default is SLS = $(AGLS_i \cup AGLS_{i+1} \cup ... \cup AGLS_n)$, where i indexes activity groups 1 to n.

    c. For any i where $AGLS_i = \emptyset$, let $AGLS_i$ = SLS.

2. Test all of the logical expressions at a given call to the Event Monitor. For all expressions that were specified without any ALSOTRY activity groups do the following:

    a. If $(AGLS \cap SLS) = \emptyset$, do nothing.

    b. If the expression is true, schedule the activity group.

    c. Do not modify the SLS.

3. Identify all of the logical expressions that are true and were specified with ALSOTRY activity groups.

4. Identify all of the activity groups that could create branches. They are activity groups that follow the logical expressions identified in step 3. Let I'' be a list of these activity groups. That is $I'' = \{i \in I''$ if and only if activity group i meets these criteria$\}$.

5. If the intersection of the stand label set and the activity group label set is null, then the activity group is not scheduled. That is, let $I' = \{i \in I'$, if and only if $(SLS \cap AGLS_i) \neq \emptyset$ for all $i \in I''\}$. If $I' = \emptyset$, processing is complete, otherwise continue with step 6.

6. Create a set I that contains elements of I' that represent unique activity groups. Two activity groups are defined to be unique if they contain identical activities, each activity contains identical parameters, and the first field of the THEN and ALSOTRY keywords for each group is set to the constant 1.0 (the default). The processing is difficult to explain in mathematical terms. The result is a set $I = \{i \in I$ if and only if all elements represent activity groups that are unique with respect to each other$\}$.

7. Create a node and as many branches as there are elements in I.

8. Create a "node label set" (NLS) by taking the union over the AGLS's for activity groups represented in I. That is, NLS = (AGLS$_i \cup$ AGLS$_j \cup \ldots \cup$ AGLS$_k$), where i, j, and k represent all elements in I.

9. Create a new set called the RNLS, "remaining node label set," by finding the labels that are elements of SLS and not elements of NLS: RNLS = (SLS $\cap$ NLS)^c, with respect to SLS. (The ^{c} signifies that a set complement operation take place.)

10. If RNLS $\neq \emptyset$, create an additional branch. Flag all of the logical expressions that created the node in the first place such that they will never be evaluated during the life of the new branch. Then replace SLS for this branch with RNLS.

11. If RNLS $= \emptyset$, replace the SLS for the branches created at step 7 with their respective AGLS.

12. Computational efficiency can be achieved if logical expressions can be blocked from being evaluated when the activity groups associated with them are labeled with activity group labels that are not part of the stand label set.

    Let IFSET be the union over AGLS's for a given expression; that is, IFSET = (AGLS$_k \cup$ AGLS$_{k+1} \cup \ldots \cup$ AGLS$_K$) where i indexes the K activity groups of a given logical expression. If (SLS $\cap$ IFSET) $= \emptyset$, the logical expression is flagged such that it will never be evaluated during the life of the branch. If (SLS $\cap$ IFSET) $\neq \emptyset$, the logical expression is not blocked from being evaluated.

Examples for Stand Labels

Examples of following these rules are given below to clarify their application. These examples differ from those found in the main body of the guide in that they do not attempt to illustrate how to use the label processing section to reach a specified goal. They illustrate the blind application of the rules that the program will follow given similar problems.

Consider the following schematic keyword file:

```
IF L₁
THEN
  Activity group 1
  AGLS₁ = {a, b}
ALSOTRY
  Activity group 2
  AGLS₂ = {a, c}
ALSOTRY
  Activity group 3
  AGLS₃ = {d}
ENDIF
IF L₂
THEN
  Activity group 4
  AGLS₄ = {a, c}
ENDIF
```

where the term "activity group n" refers to one or more Prognosis Model keywords that are scheduled by coding a date or cycle in the first field of the keyword; THINDBH and THINBBA are examples. AGLS = $\{m\}$ refers to the use of the AGPLABEL keyword to enter an activity group label.

Case 1:   Say that the user codes SLS = $\{a, d\}$ and L_1 and L_2 are both true.

Step 1:   SLS = $\{a, d\}$ via rule 1a.

Step 2: L_2 is specified without an ALSOTRY. $(\text{AGLS}_4 \cap \text{SLS}) = (\{a, c\} \cap \{a, d\}) = \{a\}$. L_2 is true, so schedule activity group 4 and SLS remains unchanged.

Step 3: L_1 is identified.

Step 4:   Activity groups 1, 2, and 3 are identified.

Step 5:   Create a list of activity groups that can create branches.

$(\text{AGLS}_1 \cap \text{SLS}) = (\{a, b\} \cap \{a, d\}) = \{a\},$
$(\text{AGLS}_2 \cap \text{SLS}) = (\{a, c\} \cap \{a, d\}) = \{a\},$ and
$(\text{AGLS}_3 \cap \text{SLS}) = (\{d\} \cap \{a, d\}) = \emptyset.$

Therefore, activity groups 1 and 2 can create branches.

Step 6:   For this case, we will assume that all activity groups are unique. Therefore, groups 1 and 2 can create branches and $I = \{1, 2\}$.

Step 7:   Create two replicates. Note that the activities in group 4 are already scheduled so they will be part of both replicates.

Step 8:   NLS = $(\text{AGLS}_1 \cup \text{AGLS}_2) = (\{a, b\} \cup \{a, c\}) = \{a, b, c\}$.

Step 9:   RNLS = $(\text{SLS} \cap \text{NLS})^c = (\{a, d\} \cap \{a, b, c\})^c = \{a\}^c = \{d\}$, where the complement is taken with respect to SLS.

Step 10: Since RNLS = $\{d\} \neq \emptyset$, proceed with step 11.

Step 11: Create another branch, for a total of three for this node. The SLS for this branch is $\{d\}$ and L_1 is flagged such that it will never be evaluated again for this branch.

Step 12: Set the SLS for the first branch equal to $\text{AGLS}_1 = \{a, b\}$ and the SLS for the second to $\text{AGLS}_2 = \{a, c\}$.

Step 13: The result of this step is that L_1 could be true again in the life of branches 1 and 2.

Since $\{a\} \in \text{AGLS}_1$, $\{a\} \in \text{AGLS}_2$, and $\{a\} \in \text{SLS}$, a branch will be made each time L_1 is true. This corresponds to the case referred to as "all possible combinations" in the body of the guide.

Case 2:   Say the user specifies SLS = $\{b, e\}$. Since $\text{AGLS}_4 = \{a, c\}$, and $(\{b, e\} \cap \{a, c\}) = \emptyset$, activity group 4 can never be scheduled. So for the purposes of this example, we will assume that L_2 does not exist.

Step 1:   SLS = $\{b, e\}$ via rule 1a.

Step 2:   We have assumed that L_2 does not exist, so this step does not apply to this case.

Step 3: L_1 is identified.

Step 4:   Activity groups 1, 2, and 3 are identified.

Step 5:   Create a list of activity groups that can create branches.

$(\text{AGLS}_1 \cap \text{SLS}) = (\{a, b\} \cap \{b, e\}) = \{b\} \neq \emptyset,$
$(\text{AGLS}_2 \cap \text{SLS}) = (\{a, c\} \cap \{b, e\}) = \emptyset,$ and
$(\text{AGLS}_3 \cap \text{SLS}) = (\{d\} \cap \{b, e\}) = \emptyset.$

Therefore, activity group 1 can create a branch. This case has degenerated into a situation where no branching need take place. Activity group 1 is scheduled, and the SLS is unchanged.

Case 3: The user codes SLS = Ø. Regardless of the condition of L_1 or L_2, none of the activity groups can ever be scheduled.

Rules for Multistand Policy Labels

Rules used by the multistand treatment scheduling process rely on the following definitions and conditions. Let $MPL1_j$ be the multistand policy label for policy j, and let $MPL2_j$ be the policy label up to, but not including, the location of the period within the label. If there is no period, $MPL1_j = MPL2_j$. $MPL1_j$ must be unique for all policies, but $MPL2_j$ may be the same for any subsets of policies.

Trial thinnings are done according to rules not described here. The result is that the PPE knows which stands are selected for each policy. Assume that the NOTEXACT option has been used and that the hierarchy feature is not being used.

1. Let J be a list of policies that the stand can be managed under. That is, $J = \{j \in J$ if and only if $MPL2_j \in SLS\}$.

2. Let $J_s = \{j \in J_s$ if and only if the stand was selected under policy $j\}$, and $J_n = \{j \in J_n$ if and only if the stand was not selected under policy $j\}$. Note that $J = (J_s \cup J_n)$.

3. Let $DL_s = \{MPL2_j, j \in J_s\}$, $DL_n = \{MPL2_j, j \in J_n\}$, and $DL = (DL_s \cup DL_n)$. Then define two new sets, as follows:

   $DEL_s = (DL_s)^c$, and

   $DEL_n = (DL_n)^c$, with respect to DL.

4. Replicate the stand once and let one replicate correspond to being selected and one replicate correspond to not being selected.

5. Let SLS_s become the stand label set for the stand that is selected, and SLS_n for the stand that is not selected. SLS is the original stand label set used in step 1. The stand label sets for the replicates are computed as follows:

   $SLS_n = (SLS \cap DEL_s)^c$, and

   $SLS_s = (SLS \cap DEL_n)^c$, with respect to SLS.

6. Standard processing for each replicate proceeds. The implication is that, for each replicate, the rules for label processing within the Event Monitor apply. In this way, a replicate formed here may spawn additional replicates through the decision tree logic. This occurs if a stand is selected for two or more multistand policies but has unique activity groups for each.

When the EXACT option is used, the problem is expanded such that set J is divided into more subsets in step 3. Subsets J_s and J_n are still needed; however, one additional subset is needed for each harvest policy whereby a portion of the stand is harvested and a portion is not. One replicate is needed for all elements of J_s, one for all elements of J_n, and one additional replicate for each additional subset. Further discussion of this case is beyond the scope of the guide.

When the hierarchy feature is used, a different set of rules are followed. First, note that the multistand policy labels must be unique up to the

periods. That is, $MPL2_1$ must not equal $MPL2_2$. Assume that the original stand label set contains labels for both multistand policies in the hierarchy. That is, $(MPL2_1 \cup MPL2_2) \subset SLS$. The rules are explained in the context of two examples. First, the stand is selected under the first multistand policy. The SLS for the stand is modified by removing $MPL2_2$ from the SLS, processing continues, thereby ensuring that activities that are labeled with $MPL2_2$ are not scheduled and those that contain $MPL2_2$ are scheduled. After the master cycle in which the stand was selected has been completed, $MPL2_2$ is reinserted into SLS. The second case is the reverse of the first. If the stand is not selected under the first multistand policy, and is selected under the second, $MPL2_1$ is removed from the SLS for the period of the master cycle.

Examples for Multistand Policy Labels

For these examples, we will assume that the NOTEXACT option has been used and that the multistand policy labels for three policies are as follows: $MPL1_1 = \{a.h1\}$, $MPL1_2 = \{a.h2\}$, and $MPL1_3 = \{h3\}$. Note that $MPL2_1 = MPL2_2 = \{a\}$, $MPL2_3 = MPL1_3$, and $MPL1_j$ are unique for $(j \in J) = \{1, 2, 3\}$.

Case 1: Consider the following schematic keyword file, hierarchies are not being processed:

> SLS = {a, h3}
> IF selected eq yes
> THEN
>   Activity group 1
> $AGLS_1$ = {a}
> ALSOTRY
>   Activity group 2
> $AGLS_2$ = {h3}
> ENDIF

Assume the stand is selected for policy 1 and 3 but not for 2.

Step 1: $J = \{1, 2, 3\}$ because $MPL2_1 = MPL2_2 = \{a\}$, $MPL2_3 = \{h3\}$, $\{a\} \in SLS$, and $\{h3\} \in SLS$.

Step 2: $J_s = \{1, 3\}$ and $J_n = \{2\}$.

Step 3: $DL_s = \{a, h3\}$, $DL_n = \{a\}$, and $DL = DL_s \cup DL_n = (\{a, h3\} \cup \{a\}) = \{a, h3\}$. Further, $DEL_s = (DL_s)^c = \emptyset$ and $DEL_n = (DL_n)^c = \{h3\}$, the complements taken with respect to DL.

Step 4: Replicate the stand once and select one replicate and do not select the other.

Step 5: $SLS_n = (SLS \cap DEL_s)^c = (\{a, h3\} \cap DL)^c = \{a, h3\}$, and $SLS_s = (SLS \cap DEL_n)^c = (\{a, h3\} \cap \{h3\})^c = \{a\}$, the complements taken with respect to SLS.

Now, standard processing of each replicate is done with these new stand label sets. When the Event Monitor is called, the following happens for the stand that was not selected. The logical expression is false, so none of the activity groups are even considered, and the simulation for the stand proceeds to the next time step. For the replicate that has been selected, $SLS_s = \{a\}$. You can verify that activity group 1 is scheduled because it carries $AGLS_1 = \{a\}$ and $(\{a\} \cap \{a\}) \neq \emptyset$ and $AGLS_2 = \{h3\}$, which forms an empty set when intersected with SLS_s. Therefore, only one activity group is left after step 5 of the stand label processing rules, and we have a case similar to case 2 described for the stand label rules.

Case 2:   This example illustrates a case that will lead to incorrect answers. Two identical logical expressions are coded that are true when the stand is selected. Let's consider the case where the stand is selected under for all three multistand policies at once, an error-causing condition.

```
SLS = {a, h3}
IF selected eq yes
THEN
   Activity group 1
   AGLS₁ = {a}
ENDIF
IF selected eq yes
THEN
   Activity group 2
   AGLS₂ = {h3}
ENDIF
```

Step 1: $J = \{1, 2, 3\}$ because $MPL2_1 = MPL2_2 = \{a\}$, $MPL2_3 = \{h3\}$, $\{a\} \in$ SLS, and $\{h3\} \in$ SLS. This is true for case 1 as well.

Step 2: $J_s = \{1, 2, 3\}$ and $J_n = \varnothing$.

Step 3: $DL_s = \{a, h3\}$, $DL_n = \varnothing$, and $DL = DL_s \cup DL_n = (\{a, h3\} \cup \varnothing) = \{a, h3\}$. Further, $DEL_s = (DL_s)^c = \varnothing$ and $DEL_n = (DL_n)^c = \{a, h3\}$, the complements taken with respect to DL.

Step 4:   Since $J_n = \varnothing$, no replicates will be created.

Step 5: $SLS_s = (SLS \cap DEL_n)^c = (\{a, h3\} \cap \varnothing)^c = \{a, h3\}$, with respect to SLS. So $SLS_s =$ SLS.

So far, there have been no errors in the label processing and replication process. The error occurs when the Event Monitor is called. Because the activity groups are unique, we assume that the user desires that two replicates be created and the activities in group 1 be scheduled for multistand policies 1 and 2 and activity group 2 be scheduled, as a separate replicate, for multistand policy 3. Tracing through the stand label processing rules reveals a different, and in this case, wrong result.

Step 1: $SLS = \{a, h3\}$ as found above.

Step 2:   Both logical expressions were specified without ALSOTRY keywords and both logical expressions are true. And since $(AGLS_1 \cap SLS) = (\{a\} \cap \{a, h3\}) = \{a\}$ schedule activity group 1. Furthermore $(AGLS_2 \cap SLS) = (\{h3\} \cap \{a, h3\}) = \{h3\}$ so also schedule activity group 2.

Step 3:   No true logical expressions exist that were specified with ALSOTRY keywords, so the rest of the steps may be skipped.

As you can see, both of the activity groups are scheduled together, and this is not the intended result. The correct way to code this problem is illustrated in case 1. It is interesting to note that the intended results will be simulated using this keyword segment if the stand is never selected under multistand policies carrying $MPL2 = \{a\}$ and policies $MPL2 = \{h3\}$ in the same time step. The required replicates would be created by the multistand policy scheduling component of the PPE rather than the Event Monitor. In other words, using the approach illustrated here could work

for many runs of the PPE before failing. It is difficult to diagnose problems of this kind, so care should be taken to code correct keyword files.

Case 3: Sometimes it is desirable to use more than one logical expression that contains the clause "selected eq yes" within the keyword file specified for a stand. Consider this keyword segment:

```
SLS = {a, h3}
IF selected eq yes and pai lt mai
THEN
  Activity group 1
  AGLS₁ = {a, h3}
ENDIF
IF selected eq yes and pai ge mai
THEN
  Activity group 2
  AGLS₂ = {a, h3}
ENDIF
```

In this case, the first activity group will be scheduled when the stand is selected and the periodic annual increment is less than the mean annual increment. The second group is scheduled when the periodic annual increment is greater than or equal to the mean annual increment. There will be no erroneous results using this approach because the logical expressions are mutually exclusive. This approach is used in Example 3: Expected Value with Fire, p. 44.

APPENDIX D: KEYWORD FILE FOR EXAMPLE 4

```
COMMENT

Enter the master starting year and the number of cycles.

END
STARTYR      1990.
MSTRCYCS      12.

* Use TEMPLATE to signal that the options defined for the first stand
* apply to all stands.  Then process the first stand.

TEMPLATE
ADDSTAND
COMMENT
**********************************************************************
*                          SILVICULTURE
**********************************************************************

This run contains the following habitat types and silvicultural systems:
   Type      Code  #   Mapped to  Class  Aspect/System  Aspect/System
   --------- ---   --  ---------  -----  -------------  -------------
PSME/VACA 250   1                   1    South/         Other/
Unknown         1    PSME/PHMA      1      Shelter-burn   Clearcut-burn
ABGR/XETE 510  57                   1    SILVTYPE=1     SILVTYPE=2
ABGR/CLUN 520  18                   2
ABGR/LIBO 590  34    ABGR/XETE      2    South          Other/
ABLA/GATR 630   4    ABLA/VACA      2      Shelter-burn   Seedtree-burn
ABLA/VACA 640   0                   2    SILVTYPE=1     SILVTYPE=3
ABLA/XETE 690   2                   2
   -------------------------------------------------------------

Shelterwood-burn and Seedtree-burn:  Leave the largest larch,
Douglas-fir and lodgepole trees. Once regeneration is established
(see below), then remove left trees.
All methods:  If natural regeneration has not provided 400 trees/acre
within 10 years, then mechanically prep and plant 400 trees/acre.

Stocking control for all areas is described below.

**********************************************************************
Set up the species preference keywords.
**********************************************************************
END
SPECPREF      1.        2.         -50.
SPECPREF      1.        3.         -500.
SPECPREF      1.        7.         -50.
COMMENT
**********************************************************************
                   Set up HARVYEAR and MANAGED
Let HARVYEAR be the year that the harvest cut is accomplished.  The
value is initialized to zero and set to the harvest year when
harvesting takes place (detected and set below under Establishment).
If the harvest year is over 50 years ago, HARVYEAR is reset to zero.
MANAGED is set initially to NO (=0.0) for all stands and to YES (=1.0)
after the stand is selected for harvest.  The value of MANAGED is used
to compute the priorities for selecting stands for harvest.  Stands
that have not come under management are not thinned in this run.
**********************************************************************
END
COMPUTE     1.
HARVYEAR = 0
MANAGED  = NO
END
IF
HARVYEAR GT 0 AND YEAR-HARVYEAR GE 50
THEN
COMPUTE
HARVYEAR = 0
END
ENDIF

**********************************************************************
* Set up the classifications of the stands as to silviculture.
**********************************************************************

IF          999.
ASPECT GE 150 AND ASPECT LE 210 AND SLOPE GE 10
THEN
COMPUTE
SILVTYPE = 1
END
ENDIF
IF          999.
(ASPECT LT 150 OR ASPECT GT 210 OR SLOPE LT 10) AND (HABTYPE LE 510)
THEN
COMPUTE
SILVTYPE = 2
END
ENDIF
```

```
IF          999.
(ASPECT LT 150 OR ASPECT GT 210 OR SLOPE LT 10) AND (HABTYPE GE 520)
THEN
COMPUTE
SILVTYPE = 3
END
ENDIF
COMMENT
**********************************************************************
                    Set Stocking Control (managed stands).
Enter no more often than every 20 years
1. When BA is less than 20 and TPA is over 1500, then cut back to 900.
2. When BA is over 20 and less than 70 and if TPA is over 900, then
   cut back to 700 TPA.
3. When BA is over 70 and TPA is over 650 then cut back to 500 TPA.
**********************************************************************
END
IF          20.
BBA LT 20 AND BTPA GT 1500 AND MANAGED EQ YES
THEN
MINHARV      0.        0.        0.        0.
THINBTA      0.        910.
THINATA      0.        900.
AGPLABEL
TIMBER
ENDIF
IF          20.
BBA GE 20 AND BBA LT 70 AND BTPA GT 900 AND MANAGED EQ YES
THEN
MINHARV      0.        0.        0.        0.
THINBTA      0.        720.
THINATA      0.        700.
AGPLABEL
TIMBER
ENDIF
IF          20.
BBA GE 70 AND BTPA GT 650 AND MANAGED EQ YES
THEN
MINHARV      0.        0.        0.        0.
THINBTA      0.        510.
THINATA      0.        500.
AGPLABEL
TIMBER
ENDIF


**********************************************************************
*                    Set up the HARVEST CUTS: Shelterwood.
**********************************************************************

IF          50.
SELECTED EQ YES AND SILVTYPE EQ 1
THEN
MINHARV      0.        3000.
THINBTA      0.        60.       1.
THINBTA      0.        20.       .6
ENDIF


**********************************************************************
*                    Set up the HARVEST CUTS: Clearcut.
**********************************************************************

IF          50.
SELECTED EQ YES AND SILVTYPE EQ 2
THEN
MINHARV      0.        3000.
THINDBH      0.        0.                  1.
AGPLABEL
TIMBER
ENDIF


**********************************************************************
*                    Set up the HARVEST CUTS: Seed tree.
**********************************************************************

IF          50.
SELECTED EQ YES AND SILVTYPE EQ 3
THEN
MINHARV      0.        3000.
THINBTA      0.        15.       1.
THINBTA      0.        7.        .6
AGPLABEL
TIMBER
ENDIF


**********************************************************************
*                    Set up the Shelterwood Seedtree Removal cuts.
**********************************************************************
```

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```
IF         50.
(SILVTYPE EQ 1 OR SILVTYPE EQ 3) AND YEAR-HARVYEAR GE 10 AND HARVYEAR GT 0 &
AND BTPA GT 400
THEN
COMPUTE
HARVYEAR = 0
END
MINHARV      0.          0.          0.          0.
THINDBH      0.          5.                      1.
AGPLABEL
TIMBER
ENDIF
COMMENT
*************************************************************************
       ESTABLISHMENT FOR CLEARCUTS, SHELTERWOODS, AND SEEDTREE CUTS.
When the removals are over 2999 (assume a harvest), set up the
establishment model to burn 90% of the area and allow natural to become
established.  If natural regeneration does not result in 400 trees/acre,
then prepare the site and plant 200 larch and 200 Douglas-fir per acre.
*************************************************************************
END
IF
RMCUFT GE 2999
THEN
COMPUTE
HARVYEAR = YEAR
MANAGED  = YES
END
ESTAB
BURNPREP     1.         90.
RESETAGE     0.          0.
END
AGPLABEL
TIMBER
ENDIF
IF
HARVYEAR GT 0 AND YEAR-HARVYEAR GE 10 AND ATPA LE 400
THEN
ESTAB
MECHPREP     0.         70.
PLANT        1.          2.        200.
PLANT        1.          3.        200.
RESETAGE     0.          0.
END
AGPLABEL
TIMBER
ENDIF
*************************************************************************
*  Set the stand policy label so that all stands are part of the
*  TIMBER management policy.
*************************************************************************
SPLABEL
TIMBER
*************************************************************************
*                    END OF GLOBAL OPTIONS.
*************************************************************************
STDIDENT
51003005
DESIGN            20        100       6.00          15           1.
STDINFO          117        510                    225       20        46
INVYEAR         1982
TREEDATA          15
   1001     31LP    1  0  3  0   06 0 0 0 0 0 030


(The tree data for this stand, and the keywords for all other
 118 stands are entered here.)


COMMENT
* Enter the spatial data.
END
OPEN          24.
harvest.neig
NEIGHBOR      24.
CLOSE         24.
OPEN          24.
harvest.area
AREALOCS      24.
CLOSE         24.
```

```
* Define the multistand treatment policies.

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
MSPLABEL= TIMBER.1
END

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT &
          * DECADE(0,0,2,2,0,0,2,2,0,0,2,2)
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
SPLABEL= TIMBER.2
END

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT &
          * DECADE(2,2,0,0,2,2,0,0,2,2,0,0)
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
MSPLABEL= TIMBER.3
END

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT &
          * DECADE(3,0,0,3,0,0,3,0,0,3,0,0)
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
MSPLABEL= TIMBER.4
END

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT &
          * DECADE(0,3,0,0,3,0,0,3,0,0,3,0)
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
MSPLABEL= TIMBER.5
END

MSPOLICY                  1.
TARGET  = ((AVACC-AVMORT) + ((AVBTCUFT-5000)/50)) * MSPERIOD*TOTALWT &
          * DECADE(0,0,3,0,0,3,0,0,3,0,0,3)
PRIORITY= BMCUFT*(1-MANAGED*.5)
CREDIT  = RTCUFT*STANDWT
MSPLABEL= TIMBER.6
END

MXCLRCUT      40.
COMMENT
* Project this run.
END
PROJECT
COMMENT
* Create and write the composite yield tables.
END
BYMSPLB
NOACTSUM
NOSUM
AUTOID        -1.
TMB1
COPYCOMP
YIELDS
STOP
```

APPENDIX E: KEYWORD SUMMARY

This appendix lists the PPE keywords in alphabetical order. It is useful if you already know the PPE's vocabulary and only need to refresh your memory as to the command format and arguments. Page numbers printed below the keyword indicate where in the text more information about the keyword can be found.

ACTSUM
NOACTSUM
(37)

Control the printing of the individual activity summaries when YIELDS is entered; default is ACTSUM.

ADDFILE
(39)

The file referenced by the data set reference number specified in field 1 contains keyword records that are read when this keyword is specified. The file is read until an end-of-file is detected.

field 1: Data set reference number for the keyword file to add. If blank, the current keyword file is read.

ADDSTAND
(32)

Signals the PPE that the subsequent keywords are Prognosis Model keywords.

ALSOTRY
(42)

Signals that an alternative group of activities follow that will be scheduled following an event.

field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0.

AREALOCS
(53)

Signals that the stand areas and locations are to be read from the data set referred to by the number in field 1. If a negative number is entered, any currently stored data are forgotten. Records need not be in sorted order.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the location data to meters (UTM coordinates); default is 1.0.

field 3: A multiplier used to scale the area data to acres; default is 1.0.

Supplemental data records:

cols 1-8: The stand identification code. If blank, the record is ignored. If "–999" is coded anywhere in columns 1-8, end-of-file is assumed.

cols 11-20: The east-west coordinate of the stand centroid. If blank, the location data are not saved.

cols 21-30: The north-south coordinate of the stand centroid. If blank, the location data are not saved.

cols 31-40: The area of the stand. If blank, the area is not saved.

AUTOID
NOAUTOID
(37)

Request the PPE to generate unique management identification codes for summary tables and the composite yield tables. NOAUTOID turns the option off and is the default.

field 1: The starting sequence number for the identifica-
tions, zero is the default. If you enter a negative
number, the starting identification is entered on
a supplemental data record, and it may include
alpha codes.

Supplemental data record:

cols 1-4: The template for identification codes. The
template may be up to four characters long. If
the last one, two, three, or four characters are
a number, then that number is the starting se-
quence number. Examples: For a template
ABC9, the first four identifications are ABC9,
AB10, AB11, and AB12. For a template of
HARV, the first four are HARV, HAR0, HAR1,
and HAR2.

BYMGMID
(36)
All of the stands that have the same management will be
grouped. A composite yield table is generated for each
management identification.

BYMSPLB
(36)
Subgroups of stands are formed for each multistand treat-
ment policy; a composite yield table is generated for each.

BYSPLAB
(36)
A list of unique stand policy labels is created by the PPE
(by taking a union over all stand policy label sets). Sub-
groups are formed for each unique label by creating lists of
stands that contain the unique label in the stand policy la-
bel set. A composite yield table is generated for each stand
policy.

BYSTAND
(36)
All of the stands that have the same stand identification
will be grouped. A composite yield table is generated for
each unique stand identification.

CLOSE
(41)
field 1: Data set reference number to close.

CMUNIT
NOCMUNIT
(49)
Activate the coordinated management unit logic for select-
ing stands.

COMMENT
(39)
Records that follow this keyword contain comments. A
record that contains 'END' in the first three columns sig-
nals the end of the comment records.

COMPID
(38)
Enter a management identification for the composite yield
tables.

Supplemental data record:

cols 1-4: The composite yield table management
identification.

COMPOSIT
NOCOMPOS
(37)
Control the creation and printing of a composite yield table
when YIELDS is entered; COMPOSIT is the default.

COPYCOMP
NOCOPCMP
(37)

Control the creation and writing of a machine-readable copy of the composite yield table when YIELDS is entered; NOCOPCMP is the default.

field 1: Data set reference number; default is 4.

COPYSUM
NOCOPSUM
(37)

Control the writing of the individual summary tables when YIELDS is entered; NOCOPSUM is the default.

field 1: Data set reference number; default is 4.

CVOUTPUT
(38)

Generate reports computed by the Cover Model for stands that are selected using the "SEL..." options.

field 1: If any number greater than zero is entered, canopy cover statistics (see fig. 2 of Moeur 1985) are printed.

field 2: If any number greater than zero is entered, shrubs statistics (see fig. 4 of Moeur 1985) are printed.

field 3: If any number greater than zero is entered, the canopy and shrubs summary (see fig. 2 of Moeur 1985) is printed.

field 4: If any number greater than zero is entered, a selected set of canopy and shrub statistics is written to a data set referred to in field 5 without headings. The data elements in this file and the file format are described in appendix B.

field 5: Data set reference number for cover data written without headings; default is 24.

DEBUG
NODEBUG
(68)

Control the printing of PPE debug output; NODEBUG is the default.

field 1: Enter a data set reference number for PPE and Prognosis Model output; a blank field leaves the default unchanged.

DEFCCUT
(49)

A clearcut is a stand that has a top height that is less than the height coded on field 1 of this keyword *and* has less than the number of trees per acre coded on field 2.

field 1: Enter the top height that must be exceeded if a stand is considered "not clearcut"; default is 10 feet.

field 2: Enter the density that must be exceeded if a stand is considered "not clearcut"; default is 60 trees/ acre.

ENDFILE
(39)

field 1: Data set reference number to write an end-of-file; no default, an entry is required.

EXACT
NOTEXACT
(49)

Signal that the PPE should exactly meet the target by selecting partial stands (EXACT is the default), or should meet the target on the average and only cut complete stands.

INTERACT
(32)

field 1: The master cycle number that will be processed using the within-cycle stand interaction logic; if blank, the keyword affects all cycles.

LABWTS
NOLABWTS
(38)

Request that the label and weights file be written when YIELDS is entered; NOLABWTS is the default.

field 1: Data set reference number on the LABWTS keyword; there is no default.

LABWTSID
(38)

Enter a four-character identification for the label and weights records created when the LABWTS keyword is used.

Supplemental data record:

cols 1-4: The label and weights identification, default is " LBW".

LDMGMTID
(54)

Signal that a list of stand identifications and corresponding management identification codes be read from the dataset referred to by the number in field 1. If "−999" appears in columns 1-8 it is interpreted as end-of-data.

field 1: The data set reference number of the stand and new management identifications.

Supplemental data records:

cols 1-8: The stand identification code; if blank the record is ignored.

cols 10-13: The new management identification code.

MSPOLICY
(47)

Signal that a multistand treatment policy will be entered.

field 1: Enter the policy number. If blank, the PPE assigns the next available number. If the entry contains a number that has already been used, the old policy definition is replaced.

field 2: Enter any number to indicate that you want reports printed for this policy; default is no reports.

field 3: Enter the initial value of OLDTARG, a variable that can be used in the target expression.

field 4: Enter any number to indicate that you want a policy hierarchy.

field 5: Enter any number to indicate that you want the debug output printed (this is a lot of output designed to be read by system programmers); default is no debug output.

Supplemental data records:

TARGET = Enter an algebraic expression that defines the policy target. The expression may contain variables listed in table 1, constants, and all operators used in the Event Monitor

except logical operators. Rules for coding expressions described for the Event Monitor apply.

PRIORITY =   Enter an algebraic expression that defines stand selection priorities. The expression may contain variables that may be used in Event Monitor expression except those defined only after thinning each cycle. The PRIORITY for selecting a stand may be a function of variables defined using the COMPUTE facility. For example, you may define the variable ENTERED as being equal to 0.0 if the stand has never been entered, and equal to 1.0 once the stand has been entered. The value of ENTERED may then be used in computing the PRIORITY.

CREDIT =   Enter an algebraic expression that defines the method used to calculate each stand's contribution toward meeting the target. The expression may contain Event Monitor variables, constants, and operators other than logical operators. Rules for coding expressions described for the Event Monitor apply.

MSPLABEL =Enter the policy label; see the section Multistand Policy Labels.

END   End of the supplemental data records.

MSTRCYCS   field 1: The number of master cycles; default is 1.
(32)

MSTRINT   field 1: The master cycle number that the time interval
(32)   will be changed; default is all cycles.

field 2: The time interval; default is 10 years.

MXCLRCUT   Activate the maximum clearcut constraint logic.
(49)
field 1: Maximum clearcut size in acres.

NEIGHBOR   Signal that the neighbors file is to be read from the data
(53)   referred to by the number in field 1. If a negative number entered, any currently stored data are forgotten. Records need not be in sorted order.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the border length data to meters; default is 1.0.

Supplemental data records:

cols 1-8:   One stand identification code. If blank, the record is ignored. If "-999" is coded anywhere in columns 1-8, end-of-file is assumed.

	cols 11-20: A neighboring stand identification code. If blank, the record is ignored.
	cols 21-30: The length of the boundary between the two stands. If blank, the stands are considered neighbors that touch at one point.
NEWEIGHT (37)	Enter a new branch weighing factor for a given stand. The weighing factor is used in computing all subsequent composite yield tables.
	Supplemental data record:
	cols 1-20: The ISN for the stand with the new weight.
	cols 21-30: The new branch weighing factor.
NOBYGRP (36)	Turn off the effect of previously specified "BY..." keywords.
NOSELECT (35)	Turn off the effect of all other "SEL..." options.
OPEN (39)	A FORTRAN file OPEN is requested using this keyword. The file name is entered on a supplemental record. Note that not all FORTRAN file attributes are supported by the PPE; some are valid for one operating system and not for another. Regardless of the operating system, the file must be a formatted, sequential file.
	field 1: Data set reference number (or UNIT) to open; no default.
	field 2: Enter a nonzero value if blanks in the data set are to be treated as NULL characters. Enter a blank field or a zero (which is the default) to signify that blanks be treated as zeros when the file is read for numeric data.
	field 3: Enter a code for the file status: 0 (or leave the field blank) for UNKNOWN, 1 for NEW, and a 2 for OLD, and 3 for FRESH or REPLACE (not supported on all machines).
	field 4: The MAXRECL or MRECL parameter, depending on the computer vendor; default is 80 characters.
	Supplemental data record:
	cols 1-80: Enter the data set name with no leading blanks.
PAUSE (32)	field 1: The master cycle number in which the projection will end in a pause condition. If blank, a pause will occur as soon as the keyword is entered.
PPEINIT (33)	Reinitialize the PPE.
PROJECT (32)	Signal the PPE that all of the individual stands have been entered and that the projection should start. If a scheduled PAUSE has been executed in a previous run, the PROJECT keyword is used to resume a projection.

RDACCESS
(55)

Signal that access to roads file be read from the data set referred to by the number in field 1. If a negative number is entered, any currently stored data are forgotten. Records need not be in sorted order.

field 1: The data set reference number of the area and stand locations file; no default. The file must adhere to the format described below.

field 2: A multiplier used to scale the access data.

Supplemental data records:

cols 1-8: The stand identification code. If blank, the record is ignored. If "–999" is coded anywhere in columns 1-8, end-of-file is assumed.

cols 11-20: A measure of accessibility.

READHIST
(67)

field 1: Dataset reference number of the History file. Used to cause the program to read the history file. A blank field leaves the default unchanged.

RESTORE
(33)

Restore the PPE's memory after a pause has been executed.

REWIND
(39)

field 1: Data set reference number to rewind; no default, an entry is required.

SELISN
(34)

Enter the ISN of stands to be processed when YIELDS and/or STNDTABS are requested.

Supplemental data record:

cols 1-20: Enter the internal stand number for the stand that will be selected. If blank, select all stands. If cols 21-40 are entered, col 1-20 specifies the lower end of a range of internal stand numbers.

cols 21-40: Enter the internal stand number for the upper end of the range of stands to be selected.

SELMGMID
(35)

Enter the management identification code for stands that are processed by YIELDS and/or STNDTABS.

Supplemental data record:

cols 1-4: The management identification code for the stand that will be selected. If blank, select all stands. If cols 11-14 are entered, cols 1-4 specify the lower end of an alphanumeric range of stand identification codes that will be selected.

cols 11-14: The alphanumerically largest management identification code for the stand(s) that will be selected.

SELMSPLB
(35)

Enter the multistand treatment policy label for stands to be processed by YIELDS and/or STNDTABS. A stand is selected for output if it applies to the multistand treatment policy specified using this option.

Supplemental data record:

Enter a policy label. If blank, select all stands. Continuation records are not allowed; the length of a multistand policy label cannot exceed 40 characters.

SELSPLAB
(35)

Enter the stand policy label set for stands to be processed by YIELDS and/or STNDTABS. A stand is selected for output if its stand policy label set contains one member label that is also a member of the set specified using this option.

Supplemental data record(s):

Enter a list of stand policy labels, separated by commas as done for the SPLABEL and AGPLABEL keywords, that will be selected. If blank, select all stands. Continuation records follow records that contain an ampersand (&). The total number of characters in all policy labels, including the separating commas, cannot exceed 100.

SELSTAND
(34)

Enter the stand identification code for stands that are processed by YIELDS and/or STNDTABS.

Supplemental data record:

cols 1-8:   The stand identification code for the stand that will be selected. If blank, select all stands. If cols 11-18 are entered, cols 1-10 specify the lower end of an alphanumeric range of stand identification codes that will be selected.

cols 11-18:   The alphanumerically largest stand identification code for the stand(s) that will be selected.

SMPTRE
NOSMPTRE
(36)

Request the sample tree and stand attribute tables be printed (SMPTRE) or suppressed (NOSMPTRE) when STNDTABS is entered; default is SMPTRE.

SNDCMP
NOSNDCMP
(36)

Request stand composition tables be printed (SNDCMP) or suppressed (NOSNDCMP) when STNDTABS is entered; default is SNDCMP.

STARTYR
(32)

field 1: The starting year of the PPE projection; default is 0.

STNDTABS
(36)

Signal that printing of stand tables is to occur. Unless SNDCMP, NOSNDCMP, SMPTRE, and NOSMPTRE keywords are used to change default conditions, the stand composition table and the sample tree and stand attribute table are printed when this keyword is entered.

STOP
(39)

Stop the program.

SUMMARY
NOSUM
(37)

Control the printing of the individual summary tables when YIELDS is entered; SUMMARY is the default.

field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0.

TEMPLATE
(41)

Signal options entered for the next stand are inherited by subsequent stands.

THEN
(42)

Signals that activities that follow will be scheduled following an event.

    field 1: A value that is multiplied by the branch weighting factor when the event occurs; default is 1.0.

TMPLINIT
(41)

Signal that the template be suspended.

YIELDS
(37)

Signal that processing of yield data (composite and summary tables) is to occur. Unless other keywords are used to change default options, the YIELD processing consists of printing the summary statistics and activity summary tables for each stand, and, after computing a weighted average yield table from all stands, a composite yield table is printed.

The Parallel Processing Extension (PPE) of the Prognosis Model was designed to
analyze responses of numerous stands to coordinated management and pest impacts that
operate at the landscape level of forests. Vegetation-related resource supply analysis can
be readily performed for a thousand or more sample stands for projections 400 years into
the future. Capabilities for representing spatially-dependent interactions between stands,
representing contagious agents, and simulating management alternatives using decision
trees are included. Nontimber resources are explicitly represented by system components
and through links with other models. This user's guide describes what the PPE does, how
it works, and how to use it.

KEYWORDS: multistand, spatial, simulation, decision trees, resource supply, landscape,
        pests

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